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ABSTRACT

This document contains the transcript and prepared statements submitted for a Congressional hearing at the University of Missouri-St. Louis. Introductory statements by the committee chairman, Representative Doug Walgren, Representative Jack Buechner of Missouri, and Dr. Marguerite R. Barnett, Chancellor of the University of Missouri (St. Louis), are included along with the testimony of 14 witnesses. Appendices include models for simplified and standardized agreements for university-industry research from the Goverment-University-Industry-Roundtable and other material submitted for the record entitled "National Research and Development Policies for 1988 and Beyond: The CORETECH Agenda." The material: (1) examines the status of federal policies as they relate to private research and development, basic research, scientific and engineering manpower, and commercialization; and (2) summarizes the findings of the Council on Research and Technology (CORETECH) and its recommendations for federal support of scientific research and development. (CW)

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Rep. Morella

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UNIVERSITY/INDUSTRY ALLIANCES

HEARING

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDREDTH CONGRESS

SECOND SESSION

FEBRUARY 8, 1988

[No. 90]

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UNIVERSITY/INDUSTRY ALLIANCES

MONDAY, FEBRUARY 8, 1988

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Science, Research and Technology,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:50 a.m., in Room 126, J.C. Penney Building, University of Missouri, Hon. Doug Walgren presiding.

Mr. **Walgren**. I want to wish you a good morning and thank the University of Missouri for their hospitality for this field hearing of what is the Science, Research and Technology Subcommittee of the Committee on—what do we call the Full Committee now?

Mr. **Buechner**. Science, Space, and Technology.

Mr. **Walgren**. Science, Space, and Technology of the House of Representatives. And we are very pleased to be here. We feel that it is very valuable to come out to various parts of the country to try to be available to local interests and local strengths in various questions that are of real interest to the nation; and give us an opportunity to see what kinds of things that are going on; and certainly it gives some local people who may not in the normal course of affairs get to Washington—gives them an opportunity to—tell us the things that they are experiencing.

I want to particularly thank Jack Buechner for his initiative and assistance in arranging this hearing. As you know, Mr. Buechner has served on this committee and served well on it; and we appreciate the contribution that he has made to it.

And I want to thank Jimmy Hayes from the state of Louisiana for coming over from Iowa to join us for this hearing. It is good you are here; and we appreciate your participation in this committee's efforts as well.

Clearly, the country has a great stake in economics and in economic growth; in the development of research; in cooperation between universities and industry.

We know that almost all the new economic strength that we can point to in our country has come from the development of their technology.

That is particularly true in small businesses. New technology tends to start and take root in small businesses around the research centers of our country; and it is in small businesses that much of the purely new jobs that we have seen in the last decade have been created.

And it is also true that when we look at—although in the international economy, that in many ways we have to innovate rapidly so that we have the first opportunity to commercialize and to take advantage of your developments because, science and technology being what it is, the rest of the world is not far behind.

And so we need a continuing stream of new developments if our economy is to be strong in an internationally competitive world.

So the importance of what is going on in universities, and particularly whether they can increase the research efforts by various kinds of cooperative agreements with universities—with businesses and industry, is critical.

We hope that this hearing will be able to shed some light on the interest of industry in engaging and supporting university based research.

And we also hope that it will shed some light on how we can encourage the product of university research to be translated into a usable commercial enterprise.

So we appreciate the witnesses that have been gathered for this hearing. St. Louis is a particularly strong place to look at this subject because of the strength of universities in St. Louis; and because of the strength of the industries in St. Louis; and because of some of the examples of industry and university cooperation that you have developed, and which we hope the nation can learn from.

So with that, let me recognize your local congressman, Mr. Buechner for any opening comments he might like to make.

[The prepared opening statement of Mr. Walgren follows:]

OPENING STATEMENT OF HON. DOUG WALGREN

Good morning ladies and gentlemen. It is a pleasure to be here this morning at the St. Louis campus of the University of Missouri to explore issues involved in the nurturing of university-industry alliances. I want to thank Mr. Buechner for his initiative and assistance in arranging for this hearing and also thank the University of Missouri-St. Louis for making this facility available to us.

In setting the stage for our discussions this morning, I invite you to recall that the 1987 Nobel Laureate in Economics, Professor Robert Solow of MIT, was recognized for contributions which first established the connection between technology and economic growth. In fact, studies have established that from ⅓ to ½ of all U.S. economic growth has come from technological progress; and, technological progress will likely continue to be the principal factor in the long-term growth of modern industrial societies.

The significance of the basic connection between technology and economic growth has not been lost on government at all levels. Many state and local governments have developed plans for creating an entrepreneurial climate, with their research universities playing a significant role. This is natural since universities are a major source of the new knowledge which often is the basis for important commercial products and services. Universities are also the source of scientific and technical talent. The availability of skilled labor is the most influential factor in the regional location of advanced technical firms, according to a study by the Joint Economics Committee of Congress.

Many industries have historically supported research in universities to help supply their basic research needs and to help identify and recruit new talent. The linkage between industry and universities waned in the years following World War II when Federal support for university research became dominant, but industrial support has become more inportant in recent years as Federal funding has leveled off. According to statistics compiled by NSF, industrial expenditures in universities grew from $235 million in 1980 to $670 million in 1987. NSF estimates that industrial support will grow from the current 8 percent to 10-12% of university research budgets by the early 1990's. I might add that Washington University is on the list of the top 10 universities receiving industrial support in 1986.

The increasing industrial support and involvement in university research is a positive trend. In the discussions this morning, we hope to expore the experiences of specific universities and industrial firms in Missouri which have engaged in cooperative programs. Through these examples we seek to determine how the process of transferring new knowledge from the university to industrial development can be improved, what initiatives state and Federal Government might take to encourage cooperation, and how to measure the success of these interactions. In addition, we hope to elicit ideas on how to involve more small companies in cooperative programs with universities and to explore the ramifications of involvement of foreign companies in support of university research in the U.S.

We will begin this morning with a national perspective from representatives of the National Science Foundation and the National Academy of Sciences. Next we will hear from a panel of witnesses representing high technology companies in Missouri, and two panels of university representatives. Finally, we will conclude with the views of state government and a Missouri development association.

Mr. **Buechner**. Thank you, Mr. Walgren. I appreciate it, Mr. Chairman.

I am pleased to have an opportunity to welcome the Science, Space and Technology Committee and its Subcommittee to the periphery of the Second Congressional District.

We are really not in the Second District, but that does not mean that we cannot all enjoy in the St. Louis metropolitan area the fruits of these hearings.

I have been told—I do not really have any empirical evidence—but I understand that this may be the first congressional hearing ever held in the St. Louis County area.

And so I am especially honored to have that privilege to welcome you here for that reason.

And it is my honor to have such a distinguished panel. And I especially want to express my thanks to the Chairman of the Subcommittee, Mr. Walgren of Pennsylvania, and my colleague from Louisiana, Mr. Hayes, for their participation.

My colleagues in the U.S. House have fallen in love with a phrase—it is called "competitiveness." And many suggestions have been made and offered as to how this country can maintain or regain the competitive edge in world markets.

One very important and simple way is to pool our resources. That means bring together all of our resources, economic, intellectual and political.

And that is the purpose of today's hearing. Academian and industry have found it mutually beneficial to work together. The trend is evident.

According to National Science Foundation estimates, American corporate sponsorship of university research increased from 235 million in 1980 to 670 million dollars in 1987.

Federal and state governments have encouraged this trend. It is a way to improve the ability of American firms to compete in the international market.

We in government must continue to encourage this cooperation.

Universities offer a base where new and innovative research can be conducted while the business sector provides the needed capital to conduct such academic research.

It is my hope that this hearing today will help to develop a new era—an era of Americans pulling together, working to make this country stronger; to restore America's economic might; working to make America more competitive.

The key is that we must do it together. I cannot think of a more appropriate setting to showcase a hearing such as this. The St.

Louis area has the best of both worlds: strong business community and innovative academic community.

It is supplemented by the support of the state of Missouri, which I think has—excuse me. It is one of the fore-runners in setting up a science advisory for the Governor and a high technology emphasis within it's department of economic development.

And also the special relationships that exist with the University of Missouri at Rolla and here at St. Louis.

So I am pleased that so many of the area's top business and academic leaders will be testifying before us today. And thank you, and—let's make America move a little bit more forward, thank you.

[The prepared opening statement of Mr. Buechner follows:]

STATEMENT OF HON. JACK BUECHNER OF MISSOURI

Mr. Chairman, I am very pleased to have an opportuity to welcome the Science, Space and Technology Committee to my Congressional District in St. Louis County, Missouri. It is a honor to have such a distinguished panel and I want to express my thanks to the Chairman of the Subcommittee, Mr. Walgren of Pennsylvania, and to my colleague from Louisana, Mr. Hayes for their participation.

My colleagues in the U.S. House have fallen in live with a phrase—its called competitiveness. Many suggestions have been Offered as to how this country can maintain or regain the competitive edge in world markets. One very important and simple way is to pool our resources. That means bringing together all of our resources—economic, intellectual and political. That is the purpose of today's hearing.

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I can't think of a more appropriate setting to showcase a hearing such as this. the St. Louis area has the best of both worlds—a strong business community, and an innovative academic community. I'm pleased that so many of the area's top business and academic leaders will be testifying before us today.

Mr. **WALGREN**. Thank you, Mr. Buechner. Turn to Mr. Hayes for any thoughts he would like to——

Mr. **HAYES**. Well, most of my thoughts involve Congressman Buechner. As he was speaking, it occurred to me that with his propensity to get into trouble I suspect St. Louis will be the site of many future congressional hearings in——[Laughter]

I say that out of no small amount of resentment because the description that he gave the University policeman in order to have him find me at the airport this morning—he repeated a phrase started by the Republican—Mr. Lott—he told the officer to look for a Democrat who looked like he was the immediate past president of the Young Republicans. [Laughter]

I will refrain them from any further comments because I imagine the time would be better devoted to listening to you than hearing from me.

But thank you for the hospitality, and I do look forward to participating.

I was at a hearing Friday at the University of Iowa. And some of the subject matter that was touched upon there—dealing with the future of preparing young men and women for the career in science and our deficiencies as a nation—I would like to integrate into this hearing today and ask you some questions based upon some of the things that were discussed on Friday.

Thanks again.

Mr. **Walgren**. Thank you, Mr. Hayes.

Well, our first witness—we will start out with Dr. Marguerite Ross Barnett, the Chancellor of the University of the Missouri-St. Louis.

And we welcome you, and again want to express our appreciation of your hospitality.

STATEMENT OF DR. MARGUERITE R. BARNETT, CHANCELLOR, UNIVERSITY OF MISSOURI, ST. LOUIS

Dr. **Barnett**. Thank you, Congressman Buechner, Congressman Walgren, Congressman Hayes, members of the subcommittee staff.

Let me begin by complimenting the House Subcommittee on Science, Space and Technology on holding these hearings so critical to the nation's future.

Let me also take the opportunity to welcome you to the University of Missouri-St. Louis. It is an urban public research university with approximately 12,000 students who are pursuing degrees on undergraduate, professional and graduate level.

We are past the age of westward expansion. But here in St. Louis, the starting point for many 19th century pioneers is the proclaimed gateway to the west.

I think it is appropriate to point out that many people believe the remaining American frontiers are in our nation's urban centers.

American cities have experienced tremendous change in the past twenty years, two decades in which a national trend developed of creating high quality research and educational institutions in our country's largest metropolitan area.

Many of these institutions were created in direct response to a new economic reality—the loss of manufacturing jobs, the rise of a new service and information based economy, and the need for America to catch up in math, engineering and science in an increasingly competitive global economy.

After analyzing the needs of Missouri, the University of Missouri-St. Louis has identified three critical needs arising from this changed economic reality.

They are: to raise the levels of math, science and communications literacy in the general population; and to equip large numbers of students with scientific and technological training.

Two, to assess the management, technological and scientific fields required by our changing economy and enhance programs that will provide Missourians with those skills.

And three, to establish new relationships between business and the university that will bring about new products and technology transfer.

In the truest sense of our university's land-grant tradition we have established an innovative program of university community collaboration to meet these identified needs.

The program is called "Partnerships for Progress: Missouri in the Next Century."

Partnerships for Progress is designed to lay a foundation for enhanced economic development in the St. Louis area and statewide.

Last year, the Missouri General Assembly and Missouri corporations provided the initial funds to launch the program. The partnership program has three components which respond directly to the needs listed above.

They are: Project Compete, to improve precollegiate education; Project Advance, to strengthen and expand the University of Missouri-St. Louis' curriculum; and Project Succeed to extend and apply UM-St. Louis teaching, research and service resources to critical needs in the region and in the state.

The first of these, Project Compete, is a series of actions by which U.M.-St. Louis, working together with elementary and secondary schools in the larger community can unleash the talent and potential among the area's youth.

A leading example of this component is the bridge program, begun last year on an experimental basis with two predominantly black high schools in St. Louis.

Plans are currently underway to expand the program to other public and parochial schools in the city and the county. The program expands and assists secondary schools that lack the facilities needed to offer intensive and challenging instruction to those high school students who are capable of university level work, and who have demonstrated gifted ability, especially in math and science.

Instructional enrichment is offered to these capable students through tutoring, mentoring, academic advising, and advanced credit college courses.

Additionally, special in-service training for teachers is provided by University of Missouri-St. Louis faculty.

Project Compete also emphasizes teacher education in the public schools, expanding the offering for continuing education of area teachers, as well as expanding programs for students preparing for the teaching profession.

The second component of U.M.-St. Louis' partnership program is Project Advance. It addresses the goal of the university to enrich science, technology and management programs.

These include programs that will enhance the region's economic well-being, such as strengthen programs in engineering, mathematics and the sciences.

The third component of the partnership program is Project Succeed, which is designed to meet the work force and research needs related to economic development of the St. Louis region and Missouri.

Project succeed includes programs aimed to increase access to education for St. Louisans whose employment does not allow them to attend classes at traditional times and locations.

It also involves the establishment of new research centers facilitating business and industry research in collaboration with campus faculty.

About the same time that we were assessing the needs of the state for the future, another group was doing the same.

The Missouri Commission for the year 2000, co-chaired by former St. Louis mayor, John Poelker, and Missouri Secretary of State, Roy Blunt, was established by Governor Ashcroft to examine how the state could best prepare itself for the 21st century.

After analyzing the needs of Missouri, the Commission also made its recommendation. The Commission's key finding was that education was the most important element in ensuring economic prosperity in the year 2000 and beyond.

It called up all institutions of higher education to have a well-defined mission that relates to the overall goals of the state.

Furthermore, the Commission recommended that partnerships be formed among private industry, the state, other economic groups and universities to better use available resources for the future economic health of the region.

As you can see, we came up with many of the same conclusions. We are genuinely pleased that our initiative and the Commission's recommendations greatly complement one another.

We believe that we have taken the Commission's recommendations to heart in shaping our major program initiative and budget request.

The Commission understood that the state and the nation's long-term development in this transformed economy rests upon the pivotal role of its public university.

The University of Missouri-St. Louis has applied that understanding to its current mission and priorities. And I have included in your packet a commentary that was in the St. Louis Post dispatch on Monday, February 1st that says—that is called "A Springboard for a Sound Economy: UMSL's Partnerships For Progress is a Long-Term Investment in Missouri."

It was written by John Poelker, the co-chair of Missouri's Commission 2000. In that document, Mr. Poelker asserts that our partnerships for progress program reflects exactly the Commission 2000 mandate given to universities in the state of Missouri.

I believe that our Partnerships for Progress Program, which is an economic development strategy from Missouri, is a superb model for the nation as a whole.

I believe that the United States Government can and must apply this model on the federal level if the United States is to regain the economic competitiveness and leadership it possessed before World War II.

This model needs to be applied in three ways.

First, development of a program administered through the Department of Education, which would provide funding, seed money, for public urban universities, such as the University of Missouri-St. Louis, to develop projects to meet the future economic development needs of their states and regions.

Second, the government needs to fund outreach programs, like our bridge programs that create links between universities and high schools.

We need to realize that the best way to improve undergraduate education is to expand the pool of students who are prepared for rigorous and challenging university study, especially in the areas of science and mathematics.

Third, we need to fund research centers on a federal level in much the same way that Missouri currently funds certain research through the Missouri research assistance act.

This program matches corporate funding with state dollars. The United States needs to establish a national, academic, Industrial Research Act, NAIRA, that will provide funding to university based research institutions for applied research in the areas of interest to business and industry.

We need to provide the linkages that will allow for close collaboration between our universities and our business and industrial communities, so that together they can lead our nation into the 21st century prepared for its challenges.

I have also included information on the bridge programs, and a national research industrial act.

I thank you for your time today. I have provided the Committee, as I said, with further written information.

And again, I compliment the Committee on holding these hearings that are so crucial to our future.

[The prepared statement of Dr. Barnett follows:]

TESTIMONY TO THE
U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND TECHNOLOGY

FEBRUARY 8, 1988

CHANCELLOR MARGUERITE R. BARNETT
UNIVERSITY OF MISSOURI-ST. LOUIS

WE ARE PAST THE AGE OF WESTWARD EXPANSION. BUT HERE IN ST. LOUIS, THE STARTING POINT FOR MANY 19TH-CENTURY PIONEERS AND THE PROCLAIMED GATEWAY TO THE WEST, I THINK IT IS APPROPRIATE TO POINT OUT THAT MANY PEOPLE BELIEVE THE REMAINING AMERICAN FRONTIERS ARE IN OUR NATION'S URBAN CENTERS.

AMERICAN CITIES HAVE EXPERIENCED TREMENDOUS CHANGE IN THE PAST TWENTY YEARS--TWO DECADES IN WHICH A NATIONAL TREND DEVELOPED OF CREATING HIGH QUALITY RESEARCH AND EDUCATIONAL INSTITUTIONS IN OUR COUNTRY'S LARGEST METROPOLITAN AREAS. MANY OF THESE INSTITUTIONS WERE CREATED IN DIRECT RESPONSE TO A NEW ECONOMIC REALITY--THE LOSS OF MANUFACTURING JOBS, THE RISE OF A NEW SERVICE AND INFORMATION BASED ECONOMY, AND THE NEED FOR AMERICA TO CATCH UP IN MATH, ENGINEERING AND SCIENCE IN AN INCREASINGLY COMPETITIVE GLOBAL ECONOMY.

AFTER ANALYZING THE NEEDS OF MISSOURI, THE UNIVERSITY OF MISSOURI-ST. LOUIS HAS IDENTIFIED THREE CRITICAL NEEDS ARISING FROM THIS CHANGED ECONOMIC REALITY. THEY ARE:

1. TO RAISE LEVELS OF MATH, SCIENCE AND COMMUNICATIONS LITERACY IN THE GENERAL POPULATION AND TO EQUIP

LARGE NUMBERS OF STUDENTS WITH SCIENTIFIC AND TECHNOLOGICAL TRAINING;

2. TO ASSESS THE MANAGEMENT, TECHNOLOGICAL AND SCIENTIFIC SKILLS REQUIRED BY OUR CHANGING ECONOMY AND ENHANCE ACADEMIC PROGRAMS THAT WILL PROVIDE MISSOURIANS WITH THESE SKILLS; AND

3. TO ESTABLISH NEW RELATIONSHIPS BETWEEN BUSINESS AND THE UNIVERSITY THAT WILL BRING ABOUT NEW PRODUCTS AND TECHNOLOGY TRANSFER.

IN THE TRUEST SENSE OF OUR UNIVERSITY'S LAND-GRANT TRADITION, WE HAVE ESTABLISHED AN INNOVATIVE PROGRAM OF UNIVERSITY-COMMUNITY COLLABORATION TO MEET THESE IDENTIFIED NEEDS. THE PROGRAM IS CALLED "PARTNERSHIPS FOR PROGRESS: MISSOURI IN THE NEXT CENTURY."

PARTNERSHIPS FOR PROGRESS IS DESIGNED TO LAY A FOUNDATION FOR ENHANCED ECONOMIC DEVELOPMENT IN THE ST. LOUIS AREA AND STATEWIDE. LAST YEAR THE MISSOURI GENERAL ASSEMBLY AND MISSOURI CORPORATIONS PROVIDED THE INITIAL FUNDS TO LAUNCH THE PROGRAM.

THE PARTNERSHIP PROGRAM HAS THREE COMPONENTS WHICH RESPOND DIRECTLY TO THE THREE NEEDS LISTED ABOVE. THEY ARE: PROJECT COMPETE, TO IMPROVE PRE-COLLEGIATE EDUCATION; PROJECT

ADVANCE, TO STRENGTHEN AND EXPAND THE UM-ST. LOUIS CURRICULUM; AND PROJECT SUCCEED, TO EXTEND AND APPLY UM-ST. LOUIS TEACHING, RESEARCH AND SERVICE RESOURCES TO CRITICAL NEEDS IN THE REGION AND STATE.

THE FIRST OF THESE, PROJECT COMPETE, IS A SERIES OF ACTIONS BY WHICH UM-ST. LOUIS, WORKING TOGETHER WITH ELEMENTARY AND SECONDARY SCHOOLS IN THE LARGER COMMUNITY, CAN UNLEASH THE TALENT AND POTENTIAL AMONG THE AREA'S YOUTH. A LEADING EXAMPLE OF THIS COMPONENT IS THE BRIDGE PROGRAM, BEGUN LAST YEAR ON AN EXPERIMENTAL BASIS WITH TWO PREDOMINANTLY BLACK HIGH SCHOOLS IN ST. LOUIS. PLANS ARE CURRENTLY UNDERWAY TO EXPAND THE PROGRAM TO OTHER PUBLIC AND PAROCHIAL SCHOOLS IN THE CITY AND COUNTY. THE PROGRAM EXPANDS AND ASSISTS SECONDARY SCHOOLS THAT LACK THE FACILITIES NEEDED TO OFFER INTENSIVE AND CHALLENGING INSTRUCTION TO THOSE HIGH SCHOOL STUDENTS WHO ARE CAPABLE OF UNIVERSITY LEVEL WORK.

INSTRUCTIONAL ENRICHMENT IS OFFERED TO THESE CAPABLE STUDENTS THROUGH TUTORING, MENTORING, ACADEMIC ADVISING, AND ADVANCE CREDIT COLLEGE COURSES. ADDITIONALLY, SPECIAL IN-SERVICE TRAINING FOR TEACHERS IS PROVIDED BY UNIVERSITY OF MISSOURI-ST. LOUIS FACULTY. PROJECT COMPETE ALSO EMPHASIZES TEACHER EDUCATION AND THE PUBLIC SCHOOLS, EXPANDING THE OFFERINGS FOR CONTINUING EDUCATION OF AREA TEACHERS AS WELL AS EXPANDING PROGRAMS FOR STUDENTS PREPARING FOR THE TEACHING PROFESSION.

THE SECOND COMPONENT OF UM-ST. LOUIS'S PARTNERSHIP PROGRAM IS PROJECT ADVANCE. IT ADDRESSES THE GOAL OF THE UNIVERSITY TO ENHANCE SCIENCE, TECHNOLOGY AND MANAGEMENT PROGRAMS. THESE INCLUDE PROGRAMS THAT WILL ENHANCE THE REGION'S ECONOMIC WELL BEING, SUCH AS ENHANCED PROGRAMS IN ENGINEERING, MATHEMATICS, AND THE SCIENCES.

THE THIRD COMPONENT OF THE PARTNERSHIP PROGRAM IS PROJECT SUCCEED, WHICH IS DESIGNED TO MEET THE WORK FORCE AND RESEARCH NEEDS RELATED TO ECONOMIC DEVELOPMENT OF THE ST. LOUIS REGION AND MISSOURI. PROJECT SUCCEED INCLUDES PROGRAMS AIMED TO INCREASE ACCESS TO EDUCATION FOR ST. LOUISANS WHOSE EMPLOYMENT DOES NOT ALLOW THEM TO ATTEND CLASSES AT TRADITIONAL TIMES AND LOCATIONS, AND THE ESTABLISHMENT OF SEVERAL NEW RESEARCH CENTERS ON THE CAMPUS.

ABOUT THE SAME TIME THAT WE WERE ASSESSING THE NEEDS OF THE STATE FOR THE FUTURE, ANOTHER GROUP WAS DOING THE SAME. THE MISSOURI COMMISSION FOR THE YEAR 2000, CO-CHAIRED BY FORMER ST. LOUIS MAYOR JOHN POELKER AND MISSOURI SECRETARY OF STATE ROY BLUNT, WAS ESTABLISHED BY GOVERNOR ASHCROFT TO EXAMINE HOW THE STATE COULD BEST PREPARE ITSELF FOR THE 21ST CENTURY. AFTER ANALYZING THE NEEDS OF MISSOURI, THE COMMISSION ALSO MADE ITS RECOMMENDATIONS.

THE COMMISSION'S KEY FINDING WAS THAT EDUCATION WAS THE MOST IMPORTANT ELEMENT IN ENSURING ECONOMIC PROSPERITY IN THE YEAR

2000 AND BEYOND. IT CALLED ON ALL INSTITUTIONS OF HIGHER EDUCATION TO HAVE A WELL-DEFINED MISSION THAT RELATES TO THE OVERALL GOALS OF THE STATE. FURTHERMORE, THE COMMISSION RECOMMENDED THAT PARTNERSHIPS BE FORMED AMONG PRIVATE INDUSTRY, THE STATE, OTHER ECONOMIC DEVELOPMENT GROUPS, AND UNIVERSITIES TO BETTER USE AVAILABLE RESOURCES FOR THE FUTURE ECONOMIC HEALTH OF THE REGION.

AS YOU CAN SEE, WE CAME UP WITH MANY OF THE SAME CONCLUSIONS. WE ARE GENUINELY PLEASED THAT OUR INITIATIVE AND THE COMMISSION'S RECOMMENDATIONS GREATLY COMPLEMENT ONE ANOTHER. WE BELIEVE THAT WE HAVE TAKEN THE COMMISSION'S RECOMMENDATIONS TO HEART IN SHAPING OUR MAJOR PROGRAM INITIATIVES AND BUDGET REQUESTS. THE COMMISSION UNDERSTOOD THAT THE STATE AND NATION'S LONG-TERM DEVELOPMENT IN THIS TRANSFORMED ECONOMY RESTS UPON THE PIVOTAL ROLE OF ITS PUBLIC UNIVERSITIES. THE UNIVERSITY OF MISSOURI-ST. LOUIS HAS APPLIED THAT UNDERSTANDING TO ITS CURRENT MISSION AND PRIORITIES.

WE BELIEVE THAT THIS KIND OF ACTION--WHICH IS AN ECONOMIC DEVELOPMENT STRATEGY FOR MISSOURI--IS A SUPERB MODEL FOR THE NATION AS A WHOLE. I BELIEVE THAT THE UNITED STATES GOVERNMENT CAN AND MUST APPLY THIS MODEL ON THE FEDERAL LEVEL IF THE UNITED STATES IS TO REGAIN THE ECONOMIC COMPETITIVENESS AND LEADERSHIP IT POSSESSED BEFORE WORLD WAR II. THIS MODEL NEEDS TO BE APPLIED IN TWO WAYS:

FIRST, THE GOVERNMENT NEEDS TO FUND OUTREACH PROGRAMS LIKE OUR BRIDGE PROGRAM THAT CREATE LINKS BETWEEN UNIVERSITIES AND HIGH SCHOOLS. WE NEED TO REALIZE THAT THE BEST WAY TO IMPROVE UNDERGRADUATE EDUCATION IS TO EXPAND THE POOL OF STUDENTS WHO ARE PREPARED FOR RIGOROUS AND CHALLENGING UNIVERSITY STUDY, ESPECIALLY IN THE AREAS OF SCIENCE AND MATHEMATICS.

SECOND, WE NEED TO FUND RESEARCH CENTERS ON A FEDERAL LEVEL IN MUCH THE SAME WAY THAT MISSOURI CURRENTLY FUNDS RESEARCH CENTERS THROUGH THE MISSOURI RESEARCH ASSISTANCE ACT. THIS PROGRAM MATCHES CORPORATE FUNDING WITH STATE DOLLARS. THE UNITED STATES NEEDS TO ESTABLISH A NATIONAL ACADEMIC INDUSTRIAL RESEARCH ACT THAT WILL PROVIDE FUNDING TO THE RESEARCH INSTITUTIONS FOR APPLIED RESEARCH IN THE AREAS OF BUSINESS AND INDUSTRY. WE NEED TO PROVIDE THE LINKAGES THAT WILL ALLOW FOR CLOSE COLLABORATION BETWEEN OUR UNIVERSITIES AND OUR BUSINESS AND INDUSTRIAL COMMUNITIES SO THAT THEY TOGETHER CAN LEAD OUR NATION INTO THE 21ST CENTURY PREPARED FOR THE CHALLENGES THAT INEVITABLY WILL BE HURLED AT US.

I THANK YOU FOR YOUR TIME TODAY. I WILL BE PROVIDING THE COMMITTEE WITH FURTHER WRITTEN INFORMATION, FOR THE RECORD, ON PARTNERSHIPS FOR PROGRESS, THE BRIDGE PROGRAM, AND A PROPOSED NATIONAL ACADEMIC RESEARCH ACT. THANK YOU AGAIN.

MARGUERITE ROSS BARNETT

Marguerite Ross Barnett earned a BA from Antioch College and an MA and PhD. from the University of Chicago. She has taught at the University of Chicago, and at Princeton, Howard, and Columbia Universities. At the City University of New York she served as Vice Chancellor for Academic Affairs for the 21-college system, serving 180,000 students.

She is currently Chancellor of the University of Missouri-St. Louis. She serves on the Board of Directors of Mercantile Bank, the Boy Scouts, the St. Louis Symphony Society, the Arts and Education Council, and the Annie Malone Home. Recently she was appointed to the American Council on Education's Commission on Governmental Relations and the Association of American Colleges and Universities' Committee on Accreditation. In addition, Barnett is a member of Professional Associations in Political Science and South Asian Studies, a member of the Overseas Development Council, and a member of the Council on Foreign Relations.

Marguerite Barnett is the author or editor of five books and forty articles. Her book on the Tamils of South India won her the 1981 American Political Science Association award as the best political science work on cultural pluralism published in a five-year period

ST LOUIS POST-DISPATCH

COMMENTARY

A Springboard For A Sound Economy

UMSL's Partnerships For Progress Is A Long-Term Investment In Missouri

By John H. Poelker

As a new member of the Chancellor's Council at the University of Missouri-St. Louis, I have had the opportunity to review its budget request for state funding for the next fiscal year. I was struck by the degree to which the budget request and underlying rationale for funding reflect the key recommendations of the Missouri Commission for the Year 2000.

That commission, which I co-chaired with Secretary of State Roy Blunt, was established by Gov. John Ashcroft to examine how the state could best prepare itself for the 21st century. The commission emphasized that education was the most important element in ensuring employment for Missouri's workers in the year 2000 and beyond. It also recommended that partnerships be formed among industry, the state, other economic development groups and universities to boost the region's economic health. The University of Missouri-St. Louis has just such a clear mission. It is expressed in an innovative program of university-community collaboration, "Partnerships for Progress: Missouri in the Next Century."

The university's budget request is to fund this program. Missouri is changing rapidly toward an information, service and technologically based economy. The Partnership for Progress program responds to three critical needs arising from this change:

(1) To raise levels of math, science and communications literacy and to equip students with scientific and technological training;

(2) To find out what management and scientific skills are required by our changing economy and design academic programs to provide them, and

(3) To form relationships between business and the university that will bring about new products and technology transfer.

Last year the Missouri Legislature and state corporations provided the funds to launch this program. It has three components: Project Compete, to improve pre-collegiate education; Project Advance, to strengthen and expand the UMSL curriculum; and Project Succeed, to extend and apply UMSL teaching, research and service resources to critical needs in the region and state.

Project Compete addresses a key recommendation of the Missouri Commission for the Year 2000: that pre-collegiate education stress basic skills in English, science and math. Through Project Compete, UMSL works with elementary and secondary schools to unleash the potential of the area's youth.

A leading example of this component is the Bridge Program, begun last year on an experimental basis with Beaumont and Vashon high schools in St. Louis. The program assists secondary schools that lack the facilities to offer challenging instruction to high school students capable of university-level work. Plans are under way to expand the program to other public and parochial schools.

Instruction is offered through tutoring, mentoring, academic advising and advance credit college courses. Also, special in-service training for teachers is provided by University of Missouri-St. Louis faculty.

The second component of UMSL's partnership program is Project Advance. Its aim is to improve science, technology and management programs. It includes programs for the region's economic well-being, including programs in engineering, mathematics and the sciences, more graduate courses in business administration, extra support for the departments of chemistry and political science, two of the University of Missouri-designated centers of eminence at UMSL, new doctoral programs in biology and physics, new international programs, and more liberal arts offerings.

The third component, Project Succeed, is designed to meet the work force and research needs related to economic development. It addresses a key commission recommendation that industry and the state strengthen their support for research universities and for continuing education and retraining programs.

Project Succeed includes programs whose timing and location is designed to accommodate working students; a new Center for Science and Technology; and the establishment of the Center for Corneal and Contact Lens Research which, building on the strengths of the campus' School of Optometry, will research contact lens technology.

If any American frontiers remain, they are in our nation's cities. Urban America has experienced enormous change in the past two decades — decades that coincided with the growth of research and urban campuses. The University of Missouri-St. Louis' contributions to the economic vitality of the region are extraordinary. It has the largest student enrollment of any institution of higher education in the metropolitan area: 11,876 full-time students and 53,000 students in adult education and extension programs.

Annually, more of the university's graduates are employed by area employers than those of any other university.

I am delighted to see that the University of Missouri-St. Louis has taken the recommendations of the Missouri Commission for the Year 2000 to heart in shaping its programs and budget requests. The commission understood that the long-term development of our state in this transformed economy rests upon the pivotal role of its public universities.

The university has applied that understanding to its current mission and priorities. State funding of this request would help fulfill the commission's recommendations for the future vitality of the state and region.

John H. Poelker is a former mayor of St. Louis.

National Academic/Industrial Research Act (NAIRA)

Dr. M. Thomas Jones,

Interim Associate Vice Chancellor for Academic Affairs and
Professor of Chemistry
University of Missouri-St. Louis
St. Louis, Missouri 63121

The enactment of the National Academic/Industrial Research Act (NAIRA) is proposed. The purposes to be served by this act would be similar to those of the Missouri Research Assistance Act (MRAA) which are to promote research and applied projects which will enhance economic development, encourage private investment, and facilitate the process of information transfer from the universities. Since its approval by the Missouri General Assembly in 1982, the Missouri Research Assistance Act, provides up to one dollar in state funds for every two dollars in non-state, non-federal funds for university research projects which meet the general criteria set out above. In the four full years of operation since 1983, projects funded under the Missouri Research Assistance Act have shared in more than $11.2 million of which $7.7 million was provided by the private sector with the balance of $3.5 million provided by the State of Missouri. In these same four years, more than 110 projects which have involved more than 30 firms, ranging from Fortune 500 corporations such as McDonnell Douglas, IBM, and Monsanto to small, local start-up companies, have been jointly funded through the MRAA.

Based on the successful model of the Missouri Research Assistance Act it is proposed to create the National Academic/Industrial Research Fund. This Fund of $300 million, annually, would require a two-for-one match from the private sector in support of projects designed to promote research and applied projects which will enhance economic development, encourage private investment, and facilitate the process of information transfer from the universities. This would create total support in the amount of $900 million which is approximately one-half the National Science Foundation's present budget. It is further proposed that the National Academic/Industrial Research Fund be seen as the primary source of funding for the Science and Technology Research Centers program recently initiated by the National Science Foundation. Preliminary news releases by the NSF suggest that as many as 850 proposals may have been submitted to the Foundation under this program. Based on the assumption that a center would require a funding level in the range of $2 million per year, the National Academic/Industrial Research Fund could potentially support approximately one-half of the centers presently proposed

If the United States is to regain its position as undisputed economic leader of the World, it is going to take bold action by Congress and the Executive leadership such as that proposed here.

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In Touch

SPECIAL ISSUE

Notes from the Chancellor

University of Missouri-St. Louis
Volume 2, Number 3
November, 1987

Dateline 1

Plans for the 1987-1988 Bridge Program

This year, we began working with students in September at Beaumont and Vashon high schools and will continue until the end of the school year next spring. Again, a special program will be conducted during the summer. In January, the Bridge Program will be extended to the Academy of Mathematics and Science, one of the city's magnet schools.

Building on the strong base of experience and cooperation, the University of Missouri-St. Louis and faculty and staff of the St. Louis Public Schools will provide a variety of opportunities to enrich the education of the students in the city of St. Louis. Efforts will be focused on extending successful aspects of the Bridge Program from last year and developing new thrusts.

PLANNED ACTIVITIES

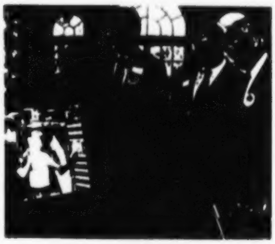
TUTORS. Tutors will work at both Vashon and Beaumont during school hours and at Beaumont and on the campus of UM-St. Louis after school hours, helping students gain a better understanding of various content areas. In addition, tutors will be available on the UM-St. Louis campus on Saturday mornings. The Bridge Program tutors will offer special emphasis in math, science and computer science. In January, tutors will be provided after school for students at the Academy of Mathematics and Science and possibly at Metro High School.

MENTORS. Students in the Bridge program will be provided with UM-St. Louis student mentors as a source of enrichment. These mentors will serve as personal role models for the high-school students as they gain information and insight about college life and mutual interests. Mentors also will provide students with information about career choices.

ADVANCED CREDIT. There are now tentative plans to offer advanced credit courses in American history, Western civilization, and general biology at Vashon and Beaumont. Political Science will be offered at the Center for Law, Management [illegible]. In January, an advanced credit science course will be offered at the Academy of Mathematics and Science. (Chemistry II is being considered.)

continued column 3

An upcoming issue of *In Touch* will focus on our 1988-89 budget request. If you have specific questions you would like to see addressed in the issue, forward them to Chancellor Barnett, 401 Woods Hall.



Message from the Chancellor

This special issue of ***In Touch*** is written to inform the campus community about our highly publicized and visible Bridge Program with the St. Louis Public Schools. The Bridge Program is one part of the University's overall initiative called "Partnerships for Progress: Missouri in the Next Century." The initiative was developed and designed to lay a foundation for enhanced economic development, not only in the St. Louis metropolitan area, but statewide.

The Bridge Program is an appropriate title for the joint cooperation between the University of Missouri-St. Louis and the St. Louis Public School System. A pilot program was implemented during the 1986-87 school year and a concentrated effort was made to deliver a wide range of initiatives designed to enhance the ability of high-school students to succeed beyond the secondary years.

We realize—and I am sure you do, also—that this program is a long-term commitment for the University of Missouri-St. Louis. We know that our plan can make a substantial difference to the people of St. Louis and to the region as a whole, if we can continue to build a spirit of partnership. In order to succeed, the Bridge Program must be more than a partnership between our University and our public school system. It needs to be a partnership involving area leaders, citizens, corporations and other educational institutions.

The goal of the Bridge Program is to increase the number of students attending college and within that increased pool to increase the number of students who are prepared and motivated to pursue careers in science, math, and technological areas. We want to encourage students to reach their full potential and provide the number of well-trained professionals needed by this community in order to retain regional prosperity into the next century. Since many of these students, and other young people, will enter the University of Missouri-St. Louis, the second part of the Partnerships for Progress initiative involves strengthening our own university programs in anticipation of new regional needs. Every School and College has received new dollars from the Partnerships for Progress program in order to strengthen their academic programs.

It has been a rewarding first year for the Bridge Program, and we are looking forward to successful implementation of the complete Bridge Program model described elsewhere in this issue.

The University of Missouri-St. Louis needs to continue to serve as a catalyst for the public school system by providing staff development, encouraging environments that foster learning, helping the schools develop incentive programs, and by keeping a sharp eye out for other areas of cooperation and other needs that can be met with the help of our expertise and resources.

Marguerite Ross Barnett

Dateline 2

ADVISING. UM-St. Louis academic advisers will meet with high-school counselors to discuss courses needed in preparation for college as well as courses that students will be expected to take in college. Special sessions to provide information to parents also will be conducted. The Bridge Program coordinator also plans to work with parents to encourage involvement in the Bridge Program.

SUMMER PROGRAM. Participants in the Fall 1987 Bridge Program will be recruited for the 1988 Summer Program. This program will be open to students at selected schools in the St. Louis Public School District as well as in the Wellston and University City Districts.

The summer programs are extremely important because they are the only component of the Bridge Program over which we have total control. We have revised our application process for this program and will begin this fall to recruit students for next summer's program and meet with parent groups.

Next summer's activities will include:

- a Sophomore Math/Science Academy for 60 students
- a Junior Math/Science Academy for 60 students
- advanced credit courses for seniors and new high-school graduates

In addition, a science and technology institute for students in the upper 5 percent of their high-school class will draw students from throughout the St. Louis metropolitan area.

SHARED RESOURCES. The success of the Shared Resource Committee—which included activities like health fairs and concerts—will be duplicated and extended to the Academy for Mathematics and Science.

STAFF DEVELOPMENT. Plans for staff development will target the teaching of reading and writing across the curriculum as well as science and math.

ACT/SAT WORKSHOPS. Students will be assisted in their college preparation with workshops to discuss how to complete the ACT/SAT tests successfully for college admittance.

EVALUATION AND ASSESSMENT. Testing and tracking of student effort will be performed to evaluate the effectiveness of the Bridge Program and to begin career counseling.

Chancellor Barnett's Open Office Hours for members of the UM-St. Louis community:

November 18 and 25,
10 a.m.-12 noon

Applause Applause

Thanks to everyone who made the Bridge Program Pilot Year a solid foundation for the future.

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Student Tutors
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Mr. **Walgren**. Thank you very much, Dr. Barnett. We appreciate that testimony. Excuse me—and I know that we have a number of witnesses who would be interested in commenting on the Missouri experience with this public funding through matching funding of research.

Is there anything else that you would like to add about your university's experience with that? Have those funds gone into facilities? Or have they been directed towards specific research projects?

How is that—what is the experience of Missouri University with that program?

Dr. **Barnett**. We have two—two centers that are currently funded through that program. One is our Center for Advanced Technology—our Center for Molecular Electronics and our center for Corneal and Contact Lens Research.

The Center for Molecular electronics focuses on the issue of super-conductivity. The money will be used for both facilities and specific research projects to facilitate a cooperative arrangement which we have with several St. Louis corporations.

The Center for Corneal and Contact Lens Research focuses, again, on joint projects between our school of optometry and certain contact lens developers in the St. Louis area.

And I believe that that specific grant will focus on the use of—the problem of clouding in soft contact lenses. And again, it is going to facilitate into a specific research project.

Mr. **Walgren**. And the moneys are made up of a portion provided by a totally private sector——

Dr. **Barnett**. That is correct.

Mr. **Walgren** [continuing]. Rate.

Dr. **Barnett**. And they are matched by the state.

Mr. **Walgren**. And matched by the state. Does the university provide support as well?

Dr. **Barnett**. The university is providing support for both of these centers.

Mr. **Walgren**. And what portion of the support would the university be providing—and is that part of the money that can draw the state money?

That is my real interest of—when we ask for what might be described as a local match, can the university draw state money directly without the private sector contributing?

Dr. **Barnett**. No, the private sector has to contribute. And then that provides the trigger for the state funding.

Mr. **Walgren**. Well, let me turn to Mr. Buechner.

Mr. **Buechner**. Dr. Barnett, I got an undercurrent in your remarks that we can set up all types of sophisticates working relationships, but if we do not get young men and women to be interested in math and the sciences at that bridge level we will not have the vital element necessary to put these programs to a useful basis, is that correct?

Dr. **Barnett**. That is absolutely correct. As we look towards the 21st century we were looking towards a change of economy. Most of the new jobs, as you know, will be in service industries, information, communication.

There will be a high and dramatic—dramatic high technology sector. We must train the young people now who will be able to participate in that changed economy effectively.

And in order for America to retain its productivity and to become more competitive we have more people who are trained to go into those jobs and to enhance our industry.

That means increasing the pool of students—especially among populations with low college going rates. That is the way to keep America competitive.

Mr. Buechner. Thank you. That is all I have.

Mr. Walgren. Okay. Mr. Hayes?

Mr. Hayes. In looking over the statement, I know the program is new with the General Assembly and corporations providing initial funds——

Dr. Barnett. That is right.

Mr. Hayes. What was the approach taken by government, and by whom? Who took the lead to induce corporations to participate in the program?

Dr. Barnett. Okay, fine.

We start—the University of Missouri-St. Louis moved simultaneously to seek funding from the legislature. At that time the legislature had a program called targeted investments; and we sought a targeted investment for Partnerships for Progress.

We were successful in receiving $1.3 million from the legislature which has gone into the partnership program. That was money which we received last year.

We are again seeking funding for this program since it must continue over a period of time in order to be effective.

At the same time, we sought money from several major St. Louis corporations. We were successful in receiving funds from the Monsanto Corporation which had supported this project generously, not only with funds but with a loaned executive.

We have since received funding from Union Electric; from the Mallinckrodt Corporation which had supported a scholarship portion of the project; and from several other St. Louis companies.

Mr. Hayes. So the University was the originator in this instance——

Dr. Barnett. That is correct.

Mr. Hayes [continuing]. Looking both towards the state and toward——

Dr. Barnett. That is correct.

Mr. Hayes. And the other part that I wanted to ask about, and I know that we have a lot of witnesses—I will not burden you—but I was looking at the instruction of Ridgemont Program. It talks about in more general terms—give me an example of one of the better specific features of it.

It says tutoring and academic advancement. Give me a more real example that I can relate to dealing with, for example, computer science, or any specific deal in this——

Dr. Barnett. In other words, what kinds of programs are we offering to these kinds of students?

Mr. Hayes. Yes.

Dr. Barnett. Well, let me just describe a—say a bit more.

We began working with these students between their freshman and sophomore years in high school in a summer program.

Then for three years after that each year the students will receive a full year and a summer of work with the University of Missouri-St. Louis.

We have our students—University of Missouri-St. Louis seniors in science and math—working in the classrooms with teachers—of course this is at the invitation of the St. Louis school system.

They offer tutoring before class, and after class; and in the summer we offered a computer science program and an integrated math and science seminar for six weeks for these students.

This was designed to encourage students to enjoy math and science. And so we introduce them to a range of traditional areas—plus to certain new areas such as biotechnology.

We had them visit companies such as Monsanto, and Emerson Electric, and Anheuser Busch. They also visited some of the local optometric companies in order to see how research was transferred—is translated into production. And they enjoyed that quite a bit, having visited the school of optometry first.

Mr. **Hayes**. Thank you very much.

Dr. **Barnett**. Okay.

Mr. **Walgren**. Thank you, Mr. Hayes.

As I just—figuring these numbers, according to the statement that program has distributed about 11 million dollars among the 110 projects which means about $110,000 per research project——

Dr. **Barnett**. Yes, we received last year about $100,000 from the Missouri program.

Mr. **Walgren**. Well, thank you very much on behalf of the Committee. We appreciate your testimony and also your university's help in holding these hearings. And we look forward to working with you in that area.

Dr. **Barnett**. Thank you very much.

Mr. **Buechner**. Thank you, doctor.

Mr. **Walgren**. Let's then call the—several people from the Federal Government—we call it a Federal panel—to talk about the role of the Federal Government, at least at present.

Dr. Don Philips, who is the Executive Director of the Government University-Industry Roundtable under the auspices of the National Academy of Sciences; and Dr. John Moore who is the Deputy Director of the National Science Foundation.

We appreciate your coming out, gentlemen. And be pleased to have your testimony in that order. And I might say, particularly for the balance of the witnesses, the records that are made at these hearings come in two parts—one is the verbal testimony that is reproduced verbatim; and at the same time written testimony will be reproduced in the hearing record as it is submitted.

And so you might not—those who will be using this record, and focus on in your oral testimony those parts that you really feel; make points that should be underscored.

And then when that is read together with the written testimony, it may have more punch to the people that review these.

But we are pleased to welcome you, and whatever way you would like to make the points that you see in these areas. And so we'll go forward in that way.

Welcome to the Committee, Dr. Phillips. And why don't you start?

STATEMENT OF DR. DON PHILLIPS, EXECUTIVE DIRECTOR, GOVERNMENT-UNIVERSITY-INDUSTRY ROUNDTABLE, NATIONAL ACADEMY OF SCIENCES

Dr. **Phillips**. Thank you, Mr. Chairman, and Congressman Buechner and Congressman Hayes.

I think holding a hearing in the field on this subject is exactly the appropriate thing to do because in this area of university/industry alliances I think most of the wisdom and innovation have come from activities at the state and local level, much more so than have come from Washington.

My name is Don Phillips. As said, I am the Executive Director of the Government-University-Industry Research Roundtable sponsored by the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine; and I'm pleased to be here today.

My remarks are based on two reports by the round table: One, "New Alliances and Partnerships in American Science and Engineering"; and the second, "State Government Strategies for Self Assessment of Science and Technology Programs for Economic Development"; and on proposals for some new Round Table activities in this area. My statement, however, expresses my interpretation of these materials and is not an official policy statement of the Research Round Table, nor of its three sponsoring organizations.

I think it's important to note as we begin that all is not new in university/industry programs.

Commentators sometimes write as if these relationships were totally new. In fact, recognizable antecedents go far back in time.

Propositions about a natural chasm between academic science and industrial science have often been drawn too sharply and too globally.

Indeed, academic science and industrial science in the United States grew up together. It is certainly true, however, that currently we are seeing an explosion in the number of alliances; and we are observing qualitative differences in their form.

What lies behind this recent surge? Universities are seeking new support for research, including equipment and facilities; ways to strengthen education programs; new outlets for faculty interested in commercial and entrepreneurial activities; and increased effectiveness in contributing through local, regional and national goals.

Industry looks to the new alliances as a source of talent—both students and faculty—as a window on new areas of science and engineering, and as a source of specific ideas for improvements in products and processes.

Federal and state governments look to enhance linkages between university and industry as one means to maintain or regain technological primacy in a variety of industries, and thereby to nurture state, regional, and national economic growth.

The alliances are characterized by a great deal of variety and diversity. University cultures vary, as to their attitudes towards the kinds of relationships with industry that are or are not appropriate.

Companies also differ in their views toward research; toward inhouse and externally sponsored research; and toward collaboration with other companies and with universities.

Given this cultural variation it is not surprising that the new partnerships vary considerably in the kinds of activities and arrangements that are involved.

One could say that it is due in part to this variety that the collaborative programs generally appear to be working so well. Participating institutions indicate that they have not found it necessary to compromise the cultures and values they deem essential to their missions.

They seem to have managed matters by selecting partners and arranging programs best suited to their particular goals and responsibilities.

The key to achieving these matches is to talk early and talk often.

The dominant view now about the alliance is it appears to be that the nation is engaged in a broad-based and diverse series of experiments that should be continued and that have the potential to be good for business, helpful and appropriate for universities, and in the public interest.

Although the grades on the initial report cards on the alliances are passing, I want to mention a few topics that continue to be discussed.

First, the area of financial support.

As has been mentioned, overall corporate support for university research has currently made it on 5 percent and probably will never exceed seven to eight percent.

Still, corporate funding is significant at some schools, reaching levels over 20 percent, and is more important in some fields than in others—notably semi-conductors and biotechnology.

There is concern about the sustainability and the breadth of this industrial funding. Will sufficient short term results materialize to maintain industry's involvement with universities over the long-term, even as the fields of interest may change?

We currently see signs of changes in industrial support for R&D, both in-house and externally. Industrial support for academic R&D must be considered as a complement to, not a substitute for, state and federal support.

The general view is that federal funding of academic research is critical, both for the long term vitality of research and graduate education, and for tracking industrial support.

Second point has to do with the industrial influence on academic research which has been a major concern raised by university/industry cooperation. It does not appear that this is occurring.

University and industrial participants are in the main agreeing on the research that warrants support. One view is that the major cultural change in universities came after World War II when agencies like DOD and NIH began to support really fairly directed basic research.

In this light, industrial support is only a small perturbation.

Third point has to do with what we call industry/university symmetry. The capacity of a company to assimilate advances in research is related to the internal technical capabilities of the company.

A break down in symmetry between the technical capabilities of cooperating companies and universities will inhibit the ability of the company to transfer innovative ideas into technology.

Internal industry R&D is an important component of technological innovation. And industry must maintain its investments in inhouse research if it is to benefit from participation in collaborate programs with universities.

Participation in such programs cannot be viewed as a substitute for internal industry R&D.

Finally, all the collaborative programs give personal contact between industrial and university scientists as an essential mechanism for moving research results from universities into industry.

Experience indicates that there are difficulties in achieving this, especially when the cooperating institutions are geographically distant; but there is evidence of progress and a willingness to participate.

In addition to the growth in university industry alliances, the last five to eight years have seen a new entrant into science and technology policy affairs, as we have heard, state governments.

Motivated by their traditional concern with economic development and the perception that new approaches, centered around science, technology and new business development, are required to achieve their economic goals, State governments have increased their investments in science and technology and taken on new roles and created new organizational structures to administer and guide these investments.

Governors are appointing science advisors; creating special commissions and corporations for science, technology and economic development; and together with state legislatures are creating a wide range of new programs.

A national survey by the Minnesota governor's office of science and technology identified over $700 million in state technology programs in fiscal year 1986.

Ten of the 43 states that supports science and technology provide over 20 million dollars per year, per state. For all states the average level of support for these special programs is about 12 million per year per state.

[Pause.]

Dr. **Phillips**. All the participants in the new alliances—federal and state governments, universities and industry—are asking the question, "What are the results?" A straightforward and expected question—but there are no simple answers.

I will make three general points.

First, as the charter for the hearing states, cooperation has taken a number of forms. Any answer to the question "What are the results," must take into account this variation and diversity.

Each type of collaborative program must be considered separately.

Second, we should not try to answer this question too quickly, at least in a conclusive manner. We need to continue to watch the experiments; make adjustments based on preliminary observations; and continue to improve and strengthen collaboration between universities and industry.

Third, each collaborative program should set reasonable goals and objectives. Program accomplishments should be measured against appropriate expectations.

Unreasonable expectations, which will lead to failing marks for the collaborative programs, will do significant harm to the participating industrial and academic institutions and to the overall science and technology enterprise.

I will conclude with two observations. As a part of these new alliances, universities are assuming visible and explicit strategic roles in state, federal and industrial economic and technological development programs.

This has resulted in increased expectations being placed on universities, and in greater political currency to university affairs, which in turn have produced both strains and benefits within the university community.

Strains are caused by different views of the new university activities tied to industry, and by the increasing political interest in universities, as indicated by the special appropriations by the U.S. Congress for university research facilities and programs.

Benefits come in the form of new state and industrial investments in university programs and the excitement resulting from the opportunity to work with new people and on new technical problems.

Reaching the right balance in these forces on the universities will require care, nurturing, and thoughtfulness by the universities themselves and by the patrons and policy makers that influence universities.

Second, the university/industry alliances should be viewed as a new and creative way to contribute to excellence in both academe and industry and not as the major national effort to solve our competitiveness problems.

The nature of research, of technology development, and of education is changing in many areas of science and engineering. Within this environment, maintaining research capacity at the frontiers of knowledge and maintaining technological capacity at the frontiers of product and process innovation require greater collaboration and interaction between academic and industrial scientists and engineers than has been the norm.

The emerging new alliances, therefore, are essential to maintaining the nation's scientific, technological and educational base.

To the extent that this base contributes to our national economic competitiveness, the alliances are an important part of the strategy.

But we know that the strategy for economic competitiveness must include many other factors of equal and perhaps even greater importance.

Thank you.

[The prepared statement of Dr. Phillips follows:]

Prepared Statement of Dr. Don Phillips at Field Hearing on University-Industry Alliances, St. Louis, MO

My name is Don Phillips. I am the Executive Director of the Government-University-Industry Research Roundtable, sponsored by the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. I am pleased to be here today to participate in the hearing on university-industry alliances convened by the House Subcommittee on Science, Research and Technology.

As stated in the charter for this hearing, all sectors of society—the federal government, state governments, industry, universities, and the general public—have a growing interest in the capacity of science and engineering to contribute to the international competitive posture of the U.S. The sectors have two principal expectations of the enterprise:

1. Advancement of knowledge, and education and training of the next generation of scientists and engineers; and
2. Achievement of specific national and local goals and the development of new products and processes.

The vitality of the enterprise is determined by the extent to which it can meet these demands and opportunities.

The Government-University-Industry Research Roundtable was established in early 1984 on the premise that the stewardship of this vitality is the responsibility of all sectors. The Research Roundtable provides a forum where scientists, engineers, administrators, and policy makers from government, universities, and industry can come together on an ongoing basis to explore ways to improve the productivity of the nation's research enterprise. The object is to try to understand issues, to inject imaginative thought into the system, and to provide a setting for the seeking of common ground.

A major element of the Roundtable's program is the examination of university alliances and partnerships with small and large companies, federal and state governments, and financial institutions. My remarks today are based on two Roundtable reports, "New Alliances and Partnerships in American Science and Engineering" and "State Government Strategies for Self-Assessment of Science and Technology Programs for Economic Development," and on proposals for some new Roundtable activities. This statement, however, expresses my interpretation of these materials and is not an official policy statement of the Research Roundtable Council nor of its sponsoring organizations.

OBSERVATION ON UNIVERSITY-INDUSTRY ALLIANCES

I will begin by reviewing three central themes that have emerged from Roundtable inquiries into university-industry cooperative programs and then move on to brief comments on selected characteristics of these programs.

Central Themes

All is not new.—Commentators sometimes write as if these relationships were totally new. In fact, recognizable antecedents go far back in time. For example, academic chemistry has from the beginning been closely tied to industrial chemistry. Much of modern biology also is deeply rooted in the search for solutions to practical agricultural, medical, and industrial problems. Similarly, computer science is closely tied to applications. And, or course, the set of applied scientific fields which call themselves "engineering disciplines" are also by their origin and their nature oriented to applications. Propositions about a natural chasm between academic science and industrial science have often been drawn too sharply and too globally. Indeed, academic science and industrial science in the United States grew up together.

It is certainly true, however, that currently we are seeing an explosion in the number of alliances, and we are observing qualitative changes in their form. What lies behind this recent surge of new arrangements among universities and industry? Universities are seeking new sources of support for research, including equipment and facilities; ways to strengthen their education programs; new outlets for faculty interested in commercial and entrepreneurial activities; and increased effectiveness in contributing to local, regional, and national technological, economic, and social goals. Industry looks to the new alliances as a source of talent—both students and faculty, as a window on new areas of science and engineering, and as a source of specific ideas for improvements in products and processes. Federal and state governments look to enhanced linkages between industry and universities as one means to maintain or regain technological primacy in a variety of industries and thereby to nurture state, regional, and national economic growth.

Variation and diversity.—The alliances are characterized by a great deal of variety and diversity. University cultures vary as do their attitudes towards the kinds of relationships with industry that are or are not appropriate. Those institutions with long standing liberal arts traditions tend to avoid relationships other than those that support basic research. The technical universities have shown a greater willingness to engage in applied research with industry funding, a greater respect for the proprietary interests of the funder, and a greater interest in continuing close interactions with industry. Companies also differ in their views toward research, toward in-house and externally sponsored research, and toward collaboration with other companies and with universities.

Given this cultural variation, it is not surprising that the new partnerships vary considerably in the kinds of activities and arrangements that are involved. Some are largely concerned with basic research. In other arrangements, the purpose of the work is to solve a well-defined practical problem. Training of undergraduate and graduate students may or may not be part of the program. Consulting by the involved university personnel is in some cases restricted, but in others, consultation is an important aspect of the arrangement. Similarly, in some cases constraints are imposed to limit faculty entrepreneurship, while in others the arrangement is designed to channel or facilitate entrepreneurship.

One might say that it is due, in part, to this variety and diversity that the collaborative programs generally appear to be working so well. Participating institutions indicate that they have not found it necessary to compromise significantly the cultures and values they deem essential to their missions. They seem to have managed matters by selecting partners and arranging programs best suited to their particular goals and responsibilities. The key to achieving these matches is to "talk early and talk often."

Benefical experiments.—The positive attitude that currently prevails in both industry and academia toward the ability of their institutions to participate in cooperative programs without distorting the institutions' cultures and values is a change from the more pessimistic tone of the discussions some ten years ago as the number of these arrangements was beginning to escalate. The dominant view now appears to be that the nation is engaged in a broad-based and diverse series of experiments that should be continued and that have the potential to be good for business, helpful and appropriate to universities, and in the public interest. There are two major concerns: (1) that the experiments will be judged too quickly and (2) that there are unrealistic and inappropriate expectations for the impacts of these new arrangements. I will have something to say about each of these concerns later in my remarks.

Selected Characteristics

Although the grades on the initial report cards on the alliances are passing, I will mention a few of the topics that are subjects of continuing discussion.

Financial support.—Overall, corporate support for university research—currently less than 5% of total support for academic research—will never exceed perhaps 7 to 8%. Industry funding for university research comes largely from corporate research budgets, which are nearly always quite small relative to development budgets and are likely to remain so. Still, corporate funding is significant at some schools, reaching levels over 20%, and is more prominent in some fields than in others. For example, the Semiconductor Research Corporation estimates that the consortium is funding nearly 50% of U.S. academic research on silicon-based integrated circuits. A survey by the Council for Chemical Research showed that industry accounted for 11% of the total extramural funding of basic academic research in chemistry in 1985 and that industry accounted for 44% of the total extramural funding for chimical engineering. A survey by David Blumenthal, then of the Kennedy School of Government at Harvard, of over 100 companies involved in biotechnology revealed that these companies provided about $120 million annually to support academic research in that field. That amount is about 30% of aggregate industrial funding of academic research and about 20% of all extramural funding of biotechnology research in academe during 1984.

There is concern about the sustainability and the breadth of this industrial funding. The new alliances are concentrated in a few industries, for example, biotechnology, microelectronics, and special materials. Will sufficient short-term results materialize to maintain industry's involvement with universities over the long-term, even as the fileds of interest may change? We currently see signs of changes in industrial support for R&D, both in-house and externally. Industrial support for academic R&D must be considered as a complement to, not a substitute for, federal support. The general view is that federal funding of academic research is critical, both for the long-term vitality of research and graduate education and for attracting industrial support.

Industrial influence on academic research.—A major concern raised by university-industry cooperation is that corporate values will divert academic research from its proper role, the search for knowledge. It does not appear that this is occurring. University and industrial participants are in the main agreeing on the research that warrants support. One view is that the major cultural change in universities came after World War II, when agencies like DOD and NIH began to support "really fairly directed basic research." In this light, industrial support is only "a small perturbation."

Faculty loyalties and incentives.—There has been a change in faculty loyalties over the past forty years. Prior to World War II, little funding was available outside the university, and faculty concerns were directed toward their own institutions. With the significant increase in federal support, there came incentives for promoting individual disciplines and growth in professional and scientific societies. Faculty loyalties were directed toward their disciplines, their colleagues in the relevant societies, and their program officers in the federal funding agencies. Now, the potential for significant increase in academic salaries through alliances with business and the financial community may diminish faculty loyalties to their universities and their disciplines. To some this is a major concern; others see this as the exception rather than the rule. They see faculty loyalties to science and engineering running high in spite of the possibility for individual financial gain.

Freedom of communication.—The alliances do not appear to be imposing unacceptable constraints on publication and communication, except perhaps in highly competitive fields like biotechnology. Here, however, views differ as to whether these constraints are brought on by commercial or scientific competition. In one sense, industrial-academic connections have served to increase communications among scientists and engineers between sectors and between disciplines.

Educational functions.—The education of graduate students and post-doctoral fellows, including foreign students, is a central feature of all of the collaborative programs examined by the Roundtable. Students are going on after graduation in significant numbers to work for the participating companies. The programs have stimulated the development of new courses and have brought about an increase in interdisciplinary, interdepartmental, and inter-university collaboration.

Cooperation among companies.—Obtaining cooperation among competing companies in academic-industrial alliances has not been a serious problem. Fear of antitrust regulations have dissipated, and cooperation among competitors that involves academe is viewed favorably within current antitrust policies. Participation in the alliances by foreign companies varies. The example of the Massachusetts General Hospital-Hoechst program is balanced by the view of a senior official of a collaborative program in the electronics field who finds if "very beneficial for [his] program to work with U.S.-based companies."

Industry-university symmetry.—The capacity of a company to assimilate advances in research is related to the internal technical capabilities of the company. A breakdown in symmetry between the technical capabilities of cooperating companies and universities will inhibit the ability of the company to transfer innovative ideas into technology. Internal industry R&D is an important component of technological innovation, and industry must maintain its investments in in-house research if it is to benefit from participation in collaborative programs with universities. Participation in such programs cannot be viewed as a substitute for internal industry R&D.

Personal contract.—All the collaborative programs view personal contact between industrial and university scientists as an essential mechanism for moving research results from universities into industry. Experience indicates that there are difficulties in achieving this, especially when the cooperating institutions are geographically distant, but there is evidence of progress and a willingness to participate.

Contract negotiations.—Industry and university officials report an increase in time and effort devoted to negotiating agreements for cooperative research programs. In an attempt to decrease this effort, the Research Roundtable and the Industrial Research Institute have just jointly published "Simplified and Standardized Model Agreements for University-Industry Cooperative Research."

NEW AND EXPANDING STATE GOVERNMENT ROLES

In addition to the growth in university-industry alliances, the last five to eight years have seen a new entrant into science and technology policy affairs—state governments. Motivated by their traditional concern with economic development and the perception that new approaches—centered around science and technology and new business development—are required to achieve their economic development goals, state governments have increased their investments in science and technology and have taken on new roles and created new organizational structures to administer and guide these investments. Governors are appointing science advisers, creating special commissions and corporations for science, technology and economic development, and, together with state legislatures, are creating a wide range of new programs—including university-industry R&D partnerships, technology transfer, small business development, entrepreneurial assistance, venture capital, and education and training.

A national survey by the Minnesota Governors' Office of Science and Technology identified over $700 million in state technology programs in FYT 1986. Over $285 million (40.8%) was earmarked for technology or research centers; another 18.1% was designated for research grants. Ten of the forty-three states that support special science and technology programs provide over $20 million per year/per state; for all states the average level of the support for these special programs is about $12 million per year/per state. The requirement for matching funds from industry is a central feature of most of these state programs. Also, it is important to note that these state appropriations are in addition to the general and continuing state appropriations for higher education.

In response to these trends, the Roundtable, in cooperation with the National Governors' Association, will initiate a process to improve communication between the federal government and the states on science and technology issues. Because of their involvement in science and technology initiatives, both industry and universities also will be involved.

The federal-state dialogue will include large policy issues as well as specific operational procedures. At the policy level, one objective of the dialogue will be to explore how the states can assume a position in national science and technology policy formulation and implementation that is commensurate with their increasing roles in supporting science and in initiating new programs. States see their participation in the national scientific enterprise as distinct from the participation of public (state) universities. At the programmatic level, the objective is to establish a mechanism for state and federal officials to discuss operational procedures in supporting research programs, centers, facilities, the small business innovation research programs, and other activities conducted in common.

IMPACTS OF THE NEW ALLIANCES

All the participants in the new alliances—federal and state governments, universities, and industry—are asking the question, "What are the results?" A straightforward and expected question, but there are no simple answers.

First, three general observations:

1. As the charter for the hearing states, cooperation has taken a number of forms. Any answer to the question—"What are the results?"—must take into account this variation and diversity. Each type of collaborative program must be considered separately.
2. We should not try to answer this question too quickly, at least in a conclusive manner. We need to continue to watch the experiments, make adjustments based on preliminary observations, and continue to improve and strengthen collaboration between universities and industry.
3. Each collaborative program should set reasonable goals and objectives; the program accomplishments should be measured against appropriate expectations. Unreasonable expectations, which will lead to failing marks for the collaborative programs, will do significant harm to the participating industrial and academic institutions and to the overall science and technology enterprise.

The Roundtable has examined approaches to the assessment of the impacts of university-industry cooperative research programs. I will summarize the major conclusions from that inquiry.

At this early stage in the operation of the programs, one can only monitor program operations and take readings of work in progress. The programs will have near-term or proximate objectives that focus on the program structure and operating procedures such as: strengthening graduate education in university research; creating "centers of research excellence" in selected areas of science and technology; changing university and industry culture to promote a true spirit of exchange among the university and industry scientists carrying out the collaborative research; achieving a certain ratio of industrial support to government support; and achieving a certain fraction of small and large companies participating in the program. These types of proximate objectives should be stated clearly at the outset of the program, and they should provide the focal point for the assessment of program progress and accomplishments in its early years of operation.

The processes through which R&D partnerships can contribute to technological innovation and economic development are varied and complex and require patience and a long-term perspective. Demonstrating such contributions will be difficult. As a start in exploring these connections, the Roundtable is beginning an examination of the perceptions of prominent industrialists on how the new alliances are expected to influence industrial innovation and competitiveness, if they are to do this at all. Here, it is important to point out another dimension of variation in this complex system of university-industry cooperation. The process of innovation and the sources of technical change vary by industry sector and even by the individual firm within a given sector. Understanding the contributions of the new alliances to innovation requires an examination that looks at different industries separately. For example, many new organizational forms are emerging to promote industry-industry and industry-university cooperation in the microelectronics and biotechnology industries. In the chemical industry, however, there is a long history of industry-university cooperation that continues through more traditional mechanisms. What are the rationales for the different approaches used? What does the industry expect from each? The Roundtable is looking to industrial officials to help articulate the variety of mechanisms and pathways through which the new alliances are to generate industrial innovation and enhance competitiveness in the different industry sectors.

TWO CONCLUDING OBSERVATIONS

Strategic Role for Universities

As a part of these new alliances, universities are assuming visible and explicit roles in state, federal and industrial economic and technological development programs. This has resulted in increased expectations being placed on universities and in greater political currency to university affairs, which in turn have produced both strains and benefits within the university community. Strains are caused by differing views of the new university activities tied to industry and by the increasing political interest in universities as indicated by the special appropriations by the U.S. Congress for university research facilities and programs. Benefits come in the form of new state and industrial investments in university programs and the excitement resulting from the opportunity to work with new people and on new technical problems. Reaching the right balance in the forces resulting from this new strategic role for the universities will require care, nurturing, and thoughtfulness by the universities themselves and by the patrons and policy-makers that influence universities.

Excellence in Universities and Industry

The university-industry alliances should be viewed as a new and creative way to contribute to excellence in both academe and industry and not as the major national effort to solve our competitiveness problems. The nature of research, of technology development, and of education is changing in many areas of science and engineering—particularly those areas, for example electronics, biotechnology, and materials, around which many of the alliances are forming. The changes include: the boundaries between the underlying disciplines and between basic research and applied research are blurring; advances in fundamental knowledge become relevant to technology development in the near term; R&D is dependent on and in some cases limited by sophisticated and expensive instrumentation; talented scientists and engineers are in short supply; and product life-cyles are becoming shorter. Within this environment, maintaining research capacity at the frontiers of knowledge and maintaining technological capacity at the frontiers of product and process innovation require greater collaboration and interaction between academic and industrial scientists and engineers than has been the norm.

The emerging new alliances, therefore, are essential to maintaining the nation's scientific, technological and educational base. To the extent that this base contributes to our international economic competitiveness, the alliances are an important part of the strategy. But, we know that the strategy for economic competitiveness must include many other factors of equal and perhaps even greater importance.

STATEMENT OF DR. JOHN H. MOORE, DEPUTY DIRECTOR, NATIONAL SCIENCE FOUNDATION

Dr. **Moore**. Thank you, Mr. Chairman. Let me apologize in advance for my voice. I have the ending, I hope, of kind of a bad cold here.

But let me also second Don Phillips' remarks about how appropriate it is to be holding a hearing such as this here in St. Louis.

I think that what he said about the importance of local efforts in this respect is entirely correct.

Mr. Chairman, I have a detailed statement that I would like to submit for the record. I know that you have many witnesses today and I'm going to be very brief in my summary of that statement.

It's already been mentioned, and by now it is clear, in this competitive and integrated world economy, research and development plays an increasingly important role.

There is a growing consensus that science and technology are key to the economic competitiveness. The Federal Government, the States, the universities and industry all have important roles to play in providing that technology.

The Federal Government has a primary responsibility for supporting basic research. It also does applied research and development in fields of its own needs—and here, defense, of course, is a leading example.

But in general, the Federal Government does not, and should not, do civilian product development. That kind of work should be left to industry.

State and local governments have responsibility for educational and for economic development for their own geographic regions.

State concern for economic development has grown tremendously in just the past few years.

Many States have established special organizations to provide leadership, such as the Missouri Corporation for Science and Technology.

Under its leadership, Missouri has moved to develop research parks and innovation centers. The corporation has also been working to establish new centers for advanced technology, involving both universities and industry.

This activity recognizes that economic development, new companies and new jobs can be created when the intellectual resources of good universities are brought together with industrial experience, and a few entrepreneurs.

Industry, the third major player has a large role in basic research; and it has developed some important new approaches, of which the most important has been a new emphasis on stronger ties between industry and universities—to a large degree, the subject of this hearing.

Some of these are quite far-reaching. That was in the case of the partnership between Monsanto and Washington University in biotechnology.

But others take many different forms. A recent count put the number of university-affiliated research parks at about 80. The prototype was Stanford's, established in 1951, and widely believed to have been a major factor in the development of silicon valley.

Affiliate programs are widely used. They give companies access to current research and the best of the new graduates. This is perhaps the most direct and effective way to transfer new knowledge from laboratories to factories—"this" being the new graduates.

Many of the programs of the National Science Foundation are designed to improve this technology transfer, often by encouraging cooperation between universities and industry.

Let me mention a few of these. First, there is student support. Really, the most effective way to transfer technology is to send graduating students, freshly trained in the latest techniques into industry.

And here I would mention that NSF is planning to increase the number of new graduate fellowships offered per year this year by about 200, to bring it to a total of about 700 new fellowships per year being offered by the Foundation.

In addition to that, though, the Foundation is providing support to graduate students as research assistants on NSF grants to roughly 13,000 students per year.

A second NSF program is Presidential Young Investigators. These awards provide support for most promising young investigators, and there's new Ph.D.'s going into universities—usually, with great support from industry.

A third NSF area of activity is centers. One of the most visible initiatives of the Foundation in the last few years has been the Engineering Research Centers; and we are now planning to extend that concept to the sciences in the new Science and Technology Centers.

The Engineering Research Center program had another NSF program this winter, motioning—we will start—the Industry/University Cooperative Research Center Program.

I mention that in part because one of those centers on processed analytical chemistry is located here in St. Louis at Washington University.

That was a very successful program; and it led to the Engineering Research Centers program which was launched in 1985.

These centers are located at universities. They concentrate on multidisciplinary research in areas such as combustion, biotechnology, robotics, composite materials, and intelligent systems engineering.

The Foundation is presently supporting 14 of these centers. We expect the nation would have about 25 of them.

Industrial participation is important with all the ERCs. Financial support from industry has been strong for these centers, but their participation grows much further than that.

Industry people sit on advisory committees; they help develop and guide the research programs; and they take part in the research itself.

That helps ensure that the research has roots of new problems, and it provides natural linkages between universities and industry.

This concept is going to be extended to the sciences. The new Science and Technology Centers will also be located on campuses; will all have some degree of participation by organizations from outside the university—and that usually, but not always in this case, would mean the industry.

Mr. Chairman, really it would be hard to overemphasize the importance of the cooperation that has developed between the universities and industry today.

We are finding that these cooperative ways could put existing resources to much more efficient use to speed up the transfer of knowledge from universities to industry; and thereby accelerate the innovation process.

It has been suggested that this cooperation was—cooperation which builds on the strength of many and varied institutions on both sides, might even prove to be an effective asset to the more centralized kind of partnership between industry and government that we see in Japan.

I do not know if that is true. I do not know even how well that works in Japan. But I do think that we should encourage these new arrangements in every way that we can.

Thank you. I will be happy to respond to questions now.

[The prepared statement of Dr. Moore follows:]

TESTIMONY OF DR. JOHN MOORE, DEPUTY DIRECTOR, NATIONAL SCIENCE FOUNDATION

Good morning, Mr. Chairman, and thank you for the opportunity to testify today concerning industry-university cooperation and the programs of the National Science Foundation.

In the competitive, integrated world economy that we have today, research and development plays an increasingly important role. As a result, science and engineering R and D has received a great deal of attention in recent years in Washington, in the States, in the universities, and in industry.

RESPONSIBILITIES

One reason for this increasted attention is a growing consensus that science and technology are the key to the economic competitiveness that we seek. But if that is true—and I think it is—then the question becomes, "How do we get this technology? Who is responsible for doing the research? For training the people? For providing the funding?

The answer in the 1950s and 1960s would have been "let the Federal Government do it." As long as Government was willing, why not? This was certainly comfortable for the other players.

By 1980, however, there was a growing recognition that the Federal Government could not, and should not, do it all.

With the current administration came a much clearer view that a true partnership in the support of science and engineering was necessary.

Each partner has a stake in the outcome, and each should have a well-defined role in providing support.

The partners are Federal, State, and local governments, industry, and the universities. I will say a bit to describe the responsibilities of each as we see them.

THE FEDERAL GOVERNMENT

The Federal Government shares with industry principal responsibility for supporting basic research. Overall, the Federal Government provides about two-thirds of all basic research support. There are good reasons for this:

By its nature, basic research is available to all. Its benefits accrue to the Nation as a whole, rather than to any segment or geographic region.

The Federal Government can support the best talent in the entire Nation as performers. It can consider long-term goals, and it can afford consistent funding over an extended period.

Major basic research facilities are big and expensive, and must be shared nationally—and sometimes internationally—in order to be justified. Accelerators, ships, and major telescopes are examples of this.

As we move along the continuum from basic research to development, the proper role of the Federal Government declines. In general, product development for civilian markets is not an appropriate area for Federal involvement.

Government is poorly coupled to markets. For that reason, it is prone to support the development of products that will not stand the test of the marketplace.

In recognition of the proper role of the Federal Government in supporting research, the administration has significantly shifted resources from development to basic research. Federal support of non-defense basic research has risen strongly since 1981, while support of non-defense development has declined.

SCIENCE EDUCATION

In science education, the Federal Government has an important role, but a limited and specialized one. At NSF:

We can stimulate science and engineering through fellowships and national competitions. These awards recognize and support the most promising graduate students.

We can support research and technical change in education at all levels, including such things as new curriculum materials development and distribution.

We support many graduate students through research and grants and contracts. This fosters both research and education simultaneously.

We can focus the attention on quality of education through reports, awards, and special programs.

We can provide limited support for such things as teaching equipment and faculty improvement at the undergraduate and precollege levels.

STATE AND LOCAL GOVERNMENT

The second major player in science and engineering is State and local government. State and local governments have traditionally been responsible for education and economic development in their own geographic regions.

These branches of Government bear principal responsibility for primary and secondary education. Federal programs may provide stimulation, some leadership, and specialized assistance, but the action is at the State and local levels. Recently we have seen:

Increased high school graduation requirements, emphasizing math and science.

Growing acceptance of standardized student achievement testing.

Better pay for teachers, with greater acceptance of merit pay and differentials for math and science teachers.

Higher education is also supported by the States, for very good reasons:

Most graduates stay in the area, and help to build State economies.

Much applied research on local problems is done in State universities.

State concern for economic development has grown tremendously in just the past few years. Many States have established special organizations to provide leadership, such as the Missouri Corporation for Science and Technology. Under its leadership, Missouri has moved to develop several research parks, and four innovation centers have been established.

Under legislation passed in 1986, the corporation has also been working to establish new "centers for advanced technology" involving both universities and industry. These centers will do both basic and applied research that is economically important to Missouri.

These actions all recognize that economic development—new companies and new jobs—can be made to happen when the intellectual resources of a good university are brought together with industrial experience and a few entrepreneurs.

INDUSTRY

Industry is the third major player. In recent years, industry has been encouraged and challenged in many ways, and the response is encouraging.

I mentioned earlier industry's dominant role in product development.

Market discipline is the force that drives industry to do this well.

The lack of market discipline is the principal reason why Government tends to do this job badly.

Industry also has a major role in supporting basic research, and it has developed some important new approaches that are worth nothing:

One is the rise in cooperative research arrangements. The National Cooperative Research Act of 1984 made it possible for companies to undertake joint ventures for research purposes with less concern for antitrust penalties.

This makes it possible for smaller companies to be seriously involved in basic research, where before only the largest could afford the tab.

By last July, 129 such joint ventures had been registered with the Justice Department.

Organizations like the microelectronic and computer cooperation (MCC) and the semiconductor research cooperative (SRC) are the best known, but there are many more of increasing importance.

This cooperation does not have to come at the expense of competition. Industries can cooperate in basic and even applied research, while still competing in product development marketing and production. This may be one area in which we can both have our cake and eat it, too.

Cooperation can also be between industry and Government. There are a number of cases in which industry has joined with national laboratories to pursue their common interests.

UNIVERSITIES

But perhaps the most important trend has been the strengthening of ties between universities—the actual source of new ideas and talented people—with the other players.

Until recently universities tended to look to their State governments for support of their educational programs, and to the Federal Government for support of research. These links remain primary, but they are now being supplemented by vigorous new ties between universities and industry.

Some of these are quite far reaching, as in the case of the partnership between monsanto and Washington University in biotechnology.

University industry partnerships take many different forms:

A recent count put the number of university-affiliated research parks at about 80. The prototype was Stanford's, established in 1951 and widely believed to have been a major factor in the development of silicon valley.

Affiliate programs are widely used. In return for a set annual contribution—from a few thousand to perhaps $250,000 annually, depending on size and other factors—companies get the right to have their scientists involved in university projects and to get regular briefings in areas close to their interests.

Perhaps even more important, they have an inside track to recruit the best of the new graduates. This is perhaps the most direct and effective way to transfer new knowledge from laboratories to factories.

Informal links with universities often develop when organizations like the microelectronics and computer corporation grow up—usually near major universities in order to draw the talented people they need.

Patent and publication issues, at one time a major reason for not supporting academic research, are no longer particularly troublesome. Since 1980 universities, nonprofits, and small business have been able to take title to patents on inventions done with Federal support, and many universities have become quite knowledgeable in this area.

With this background, the universities have been able to negotiate patent arrangements with industry that are satisfactory on both sides.

The same is true of publication. Universities insist—and properly so—that research results done on campus must be published freely. But this does not make it impossible for companies supporting the work to have advance notice of important developments, and in fast-changing areas this is usually enough.

NATIONAL SCIENCE FOUNDATION PROGRAMS

Better cooperation between universities and industry is really important because the cooperative efforts all help transfer technical information from where it is created to where it can be used in economically significant ways. Many of the programs of the national science foundation are designed to improve this technology transfer, often by encouraging cooperation between universities and industry. Let me mention several:

Student support: One of the most effective ways to transfer technology is to send graduating students, freshly trained in the latest techniques, into industry. NSF devotes a substantial part of its resources to supporting graduate students whose research experience gives them special skills that industry needs.

Presidential young investigators: PYI awards provide an annual research grant of $25,00 for five years. In addition, the foundation matches support the awardee obtains from other sources up to $37,500 per year. Thus a PYI awardee can receive a total of $100,00 per year.

Most of the matching funds come from industry. This establishes a strong link between the young researcher and the patron firms, which facilities knowledge transfer. Presently the foundation supports about 800 PYI's.

Small business innovation research: The SBIR Program began in NSF in 1982, and has since been expanded to other agencies. The idea is to provide grants to small businesses to allow them to do the research necessary to develop an idea into a commercial product.

Projects are divided into phases. Modest initial research support takes an idea to the point at which it appears that it might be commercially viable. A second phase scales it up to roughly the "proof of concept" stage, and at this point NSF support is over. In the third stage full scale commercial development is accomplished.

The lesson of the SBIR program is that there are many small businesses who are interested in working with university people to develop good ideas, and there are many university researchers interested in moving beyond basic research and into practical application.

Sometimes university faculty participate as consultants; in other cases they leave the university, either temporarily or permanently, to become involved fulltime in the commercial effort. Either way the flow of information between the two sectors is increased, and economic benefits are realized.

Centers: One of the most visible initiatives of the foundation in the last few years has been the engineering research centers and the extension of this concept to the new science and technology centers.

Historically, the roots of the centers concept were in the materials research laboratories (MRL's). Founded by the Department of Defense in 1960, these were transferred to NSF in 1972. The MRL's have typically had close contacts with industry, since their research is frequently very close to industrial applications.

Initially started in 1973, the Industry-University Cooperative Research Centers (IUCRC) program was expanded in 1980. These centers focus on research relevant to industry. They are set up on university campuses with modest support from NSF and larger funding from industry.

Each center is expected to be self-supporting within five years, mainly from indusrial participation. NSF now supports about 40 such centers. Many of the early ones are already self-supporting.

The engineering Research Centers (ERC), established in 1985, grew out of the IUCRC experience, but are similar in scale to the MRL's. ERC's are located at universities and concentrate on multidisciplinary research in areas such as combustion-processes, biotechnology process engineering, robotics in microelectronics processing, composite materials, and intelligent systems engineering. NSF presently supports 14 ERC's; we expect eventually to have about 25.

Indusrial participation is important in all the ERC's. Financial support from indusry has been strong. But participation goes much further: industry people sit on advisory committees, help develop and guide the research programs, and take part in the research itself. Several ERC's provide for long term visits by indisrial participants, including separate office space and laboratory access.

Industrial participation helps to insure that these research programs have roots in real and important problems. It also provides natural linkages for transferring knowledge from the university to industry.

The first ERC's were established less than three years ago. Preliminary results are encouraging enough to extend the concept to the sciences. The guidelines for the new science and technology centers (STC's) will be flexibile enough to accommodate the wide variety of subjects and approaches to research expected in the sciences.

Topics will not be predetermined by NSF but will depend on suggestions and ideas form researchers. All STC's will be located at universities, and all will have some degree of participation by organizations from outside the university. Outside participants will not always be from industry, although it is expected that most will be.

Participation by State of local government agencies or by Federal laboratories is not only possible but likely in some of the centers. In all cases, participation by outside agencies or organizations will afford a channel for direct communication of research results from the centers to potential users.

The center concept is not confined to NSF. The President's 1987 legislative message to Congress presented the centers as an administration initiative in competitiveness and urged all agencies with technical missions to consider establishing such centers.

The Departments of Energy and Agriculture are joining with NSF to establish centers in plant science, and the Department of Defense, in its university research initiative has established a number of unversity-based centers to carry out fundamental research.

SUMMARY

Mr. Chairman, I believe that it would be hard to overemphasize the importance of the cooperation that is developing between universities and industry today. We are finding that these cooperative links can put existing resources to far more efficient use, and can speed up the technology transfer and innovation process significantly.

It has even been suggested that this cooperation—which builds on the strength of our many and varied institutions on both sides—will prove to be an effective answer to the more centralized partnership between industry and government that we see in Japan. I have no way of knowing whether that will prove to be the case. But I do think we should encourage these new arrangements in every way that we can.

Mr. **Walgren**. Thank you very much, Dr. Moore.

Where are we in our ability to evaluate what's happening here? Dr. Phillips, you mentioned that the Academy has won the rule, which by its title would say that they've looked at this.

We have had an NSF, this center's program, since 1980—is that——

Dr. **Moore**. 1985. The ERC's.

Mr. **Walgren**. Yes, but I am thinking of the Industry/University Cooperative Research Centers which I see started in 1973.

Dr. **Moore**. The air was very—yes, but they really got into full gear in 1980.

Mr. **Walgren**. What is our evaluation of them as successful? You indicate, Dr. Phillips, that it is too early and you do not want to prejudge that question. And what concerns me is that we probably all ought to look at the reality whenever we can.

And it would probably not be right to go walking down this road without some specific reviews that could give us a pretty sharp assessment on this.

Dr. **Phillips**. I'll respond. First, I think there have been several assessments of the various kinds of cooperative programs.

The real difficulty comes in what the questions are that are being asked in that assessment or what the objectives are that are being evaluated.

In our own activity, in looking at the state science and technology programs and those cooperative activities that focus on research, is that it's perfectly appropriate to assess their progress and their impact in terms of objectives that have to do with the nature of the programs—how much industry is involved in supporting research? Have they attracted increase of graduate students or faculty? Have they increased their research base? Are they having truly collaborative kinds of programs with industry? Do they have small companies involved; large companies involved?

You can do that. It's perfectly appropriate to start doing that kind of evaluation after the first three, four, five years.

The major concern in some of our discussions has been, if you start asking questions like how many jobs did this cooperative program result in and you start asking that question in one, two, three years, that—in our discussions—it was felt that that is inappropriate for cooperative R&D programs.

Maybe we can get some insight into that question in 10 years, or 15 years.

Mr. **Walgren**. Well, let's say one major effort. As I understand it, the NSF program was designed to create a center that would be self-funding within a short period of time.

What has been our experience with that?

Dr. **Moore**. Well, that is the IUCRC program. That is correct.

And those—the terms of those centers are that the NSF will provide funding for a five year period only; and at the end of that period, there is no more NSF money.

And, therefore, if the center is going to continue, it has to continue on its own.

I cannot give you the actual statistics about how many of them have survived, but the first couple of rounds will have been through that five year period by now.

I do know that a number have survived, but I can't tell you just how many have.

Mr. **Walgren**. Now let me ask you to go back and look in the Foundation and give us a submission on that that would——

Dr. **Moore**. Sure.

Mr. **Walgren** [continuing]. Make some evaluation of what's happened to all these centers we have funded.

[Material referred to follows:]

Of the 12 IUCR's that have "graduated" from NSF's initial five-year support, ten are now funded by industrial concerns. The average annual support per center is $1.9 million.

The ten IUCR's operating solely with non-NSF funds are:
Massachusetts Instititue of Technology (Center for Polymer Processing.),
Rensselaer Polytechnic Institute, NY (Center for Interactive Computer Graphics),
University of Massachusetts (Center for Industry Research on Polymers),
Ohio State University (Center for Welding Research),
Case Western Reserve University, OH (Center for Applied Polymer Research),
North Carolina State University (Center for Communication and Signal Processing),
Rutgers University, NJ (Center for Ceramics),
Georgia Institute of Technology (Materials Handling Research Center),
Texas A & M University (Center for Hydrogen Technology),
Pennsylvania State University (Center for Dielectrics).

Mr. **Moore**. If I may, I could respond on the Engineering Research Centers also to let you know what the situation is there.

Those centers are a larger scale. And it is—and they have a—there is a review procedure that has been adopted by the National Science Board for those centers.

The initial award to each center is a five year reward. Each center is reviewed during its third year to give a kind of a progress—to assess its progress.

At that point a center may be given an additional five year award—taking it out to eight years; or it may be notified that it must change—things that have to be done in order that it not be terminated; or it can be given notice that it will be terminated at the end of the first five year award.

We have just been through the first round of those reviews—reviewing the first six engineering research centers. This coming week, the National Science Board at its meeting will make decisions on what to do with that first round of six.

But that is a very carefully developed procedure that is being used to evaluate those.

Mr. **Walgren**. Well, maybe also in your—look back at what our experiences—how many have continued funding; what the pressure is to continue the government funding, and substitute future government funding for what we had thought would be private sector new funding.

Dr. **Moore**. I will say that I know of no such pressure in the case of the IUCRCs. But I will——

Mr. **Walgren**. Well, I would be curious if you would not only do that for the program that has been there since 1973 but also include a summary of the recommendations to the National Science Board in this week coming. We would be interested in looking at those.

[Material referred to follows:]

The first six Engineering Research Centers underwent a review of progress and plans during the third year of each center's operation. NSF used this review in combination with past annual reviews as input into a decision to recommend either a new five year period of performance beginning in year four of center operations, or termination at the end of the current award. If a center is to be terminated, the announced procedure is to continue it on its former award instrument with phasedown funding during years four and five. NSF support would terminate at the end of year five.

Each center underwent a review using a standard set of procedures and criteria. The criteria were developed from the Engineering Research Center Program Announcement and the Cooperative Agreements between the centers and NSF. The criteria focused on performance in the following key features of an ERC: Quality of Effort in Meeting Proposed Goals, Research Quality, Integration and Focus of Research Plans, Education, Industrial Involvement and Support, Leadership and Management, Technology Transfer, University Support to Center.

Each center was site reviewed by NSF staff and consultants from industry and academia. NSF considered the evidence of performance in the prior annual reviews, center oversight interactions, and the evaluation of performance and future plans in reaching a recommendation for renewal or termination.

The NSF recommended four of the ERCs for renewal based on this review process. The centers are: Columbia University ERC on Telecommuncations, University of Maryland/Harvard University ERC on Systems Research, Massachusetts Institute of Technology ERC on Biotechnology Process Engineering, Purdue University ERC on Intelligent Manufacturing Systems.

Two of first six ERCs were not recommended for renewal. These centers have not made sufficient progress toward their proposed goals and the goals of the ERC program to warrant five more years of support. They will be phased-down over the next two years: University of California at Santa Barbara ERC for Robotic Systems in Microelectronics, University of Delaware-Rutgers University ERC on Composites Manufacturing.

Let me turn to Mr. Buechner.

Mr. **Buechner**. Don, I understand that the Roundtable has just prepared a model university-industry agreement. Would you mind telling us a little bit about that?

I would imagine this is probably one of the first general outlines in model agreements that has been prepared, is that right?

Dr. **Phillips**. Yes, and I have a copy here that I would like to enter into the record, if you wish.

Mr. **Buechner**. Mr. Chairman, do—I would like to have that in the record.

Mr. **Walgren**. Yes, we would be happy to have that as a submission to be included in the record without objection.

[See appendix, p. 161.]

Dr. **Phillips**. The—it was developed in response to the comments we were getting from both industry and university officials that, although in the dollar sense compared to federal dollars for universities, the industry dollars were small, that each agreement is negotiated from scratch; and that as the number of agreements increased, and as in some cases their complexity increased, the time and effort that was being spent both by the university and the industry on working through these agreements was increasing.

And they made comments to the Roundtable: is there something to do—that could be done to develop a simplified model that at least people could use as a starting point, not necessarily adopt in full, but hopefully adopt a large portion of it and then spend the negotiating time on those few issues that are particular to that project?

That is what we did. The process for doing it, I think, is notable in that we went to the people who have the money—the people in industry—and put together an industrial committee. They worked and developed the model through consultation with university scientists and grants administrators, and tried to get something that was agreeable to both.

And then the Roundtable working with the major industrial organization, the Industrial Research Institute, had it reviewed by them.

They made a few additional changes; and now it is being published jointly by the two organizations.

We hope that with a leading industrial organization like IRI involved it will have an impact on decreasing administrative burdens in the research system and thereby increase research productivity in the system.

Mr. **Buechner**. Is there anything in there about the protection of intellectual property?

Dr. **Phillips**. Yes, there is—and it is all attempted to be done as simply as possible, with a recognition that there are certain things that the company needs; certain things that the university needs.

And all the reviews that we have had done by people on both sides—they find it acceptable. So we are hoping that with minor modifications it can be put down on the table when a new project is started and people can agree to it.

Another major advantage—we talked a lot here; and I know states are concerned about small company participation. One of the big advantages we have seen already in just some trial runs is the use of it in small company university relations.

Small companies usually do not have large legal staffs. If they're going to develop agreement, they have to hire outside legal counsel.

In one or two cases the university has put this model agreement in front of them and said, "Save your legal fees. Why don't you just start with this?" And it has worked, and saved money, and saved a good deal of an amount of time.

Mr. **Buechner**. Well, having left the private practice of law I am glad you are using as a——[Laughter.]

I am wondering for either one of you, has the increased cooperation between university-industry changed the research agenda at all?

I guess more particularly, is NSF seeking any kind of change in the kind of proposals—or see any kind of change in the proposals that you're receiving?

Dr. **Moore**. Well, it is hard to give a comprehensive answer to that. I have not reviewed it. I do not know of anyone who has actually reviewed it.

We, of course, in these initiatives that we are starting—the Engineering Research Center's initiative, and in the Science and Technology Center's initiative—I have seen proposals of a sort that we have not seen before, and dealing with subjects that we probably would not have seen otherwise, and quite frankly things that we would never have expected to have seen.

In that respect, I would say that the answer is yes, there is a change in the kind of research that is being done.

But if I were—if I were to survey all of the awards that the NSF makes during the year—there are many thousands of awards that are made there in the year—I don't know that I would see much of a change in that pattern overall, outside of the special kinds of programs.

Mr. **Buechner**. Could either of you suggest industries that should be targeted for this type of cooperation?

Dr. **Moore**. Well, that's an interesting question. It's been suggested to us on a number of occasions that we ought to target; we ought to be picking out industries that—or areas of technology that we should focus on or request proposals for in the ERC program.

So far we have not done that. And the reason that we have not done it is, so far, we have been of a mind that we are more likely to get good proposals out of the community if we leave it up to the community to develop those proposals.

And also we are of a mind—we have thought up to now—that we can't, ourselves, sitting in Washington, figure out what are all the interesting areas that we should be putting money into.

That has been our position so far. At some point, as we get down the road a little bit, we may decide, yes, we should put a little bit of a—we should put a little bit of a twist on that pitch to the community. But so far we've not done that.

Let me give you one example of a topic that I do not think we would have probably picked ourselves if we had been targeted—and that is hazardous waste disposal, mentioned this morning.

We have a new ERC just starting up May 1 of this last year at UCLA on hazardous waste disposal. That is a very important topic, it turns out, for competitiveness—not just because it is an environmental problem, but it is also very important for competitiveness.

I just doubt that we would have thought of that topic that we sent off to——

Mr. **Buechner**. Well, Dr. Phillips pointed out that one of the best things that can be done with this model agreement is that it allows smaller companies to participate because they do not have to expend resources in the type of legal expertise necessary in putting those things together, and effectively reinvent the wheel.

Which I guess brings me to my next question which is, to what extent are small businesses able to participate in the NSF industry-university cooperation program?

Let me bring it home here. If a small Missouri corporation wanted to participate in the ERC, is that possible, or is that really just by the nature of the operation locked out to the larger corporations?

Dr. **Moore**. It's absolutely possible. It depends a little bit on the field of research; whether the companies that are in that field are typically big ones or small ones.

We have one—one ERC on biotech—process engineering at MIT. It has a number of smaller firms associated with it.

Having said that I will also say that I think this is an area where we have not been able to do as well as I think we should in reaching out to smaller businesses for the ERC program in particular.

Of course as you know we have the Small Business Innovation Research program, which has been, I think, quite successful in supporting research by small businesses.

But we need to, I think, improve what we are doing in the area of getting small businesses into the ERC's.

Mr. **Buechner**. Well, maybe hearings like this will at least let the small business community know that there are opportunities available and that there are methods by which their participation can be encouraged and expedited.

Thank you both very much.

Mr. **Walgren**. Did we reach the NSF in a SBIR, Small Business Innovation Research Program?

Dr. **Moore**. Yes, indeed.

Mr. **Walgren**. So you have to account for a certain percentage of your research and initiated dollars going to be conducted by small businesses.

Dr. **Moore**. One and a quarter percent.

Mr. **Walgren**. Are you over that?

Dr. **Moore**. I think we are pretty close to that. We may be slightly over, but certainly not significantly over.

Mr. **Walgren**. Do you keep a track of that percentage?

Dr. **Moore**. You bet.

Mr. **Walgren**. I guess I would be interested in what that percentage is. I'd like to give you a little work almost and then—seems whenever we go around we are just collecting things to do; and I do not mind adding to your to-do list.

[Material referred to follows:]

The NSF has provided 1.25 percent of its extramural research budget for support of Hi-Tech small firms under the Small Business Innovation research (SBIR) Program. (Required under provisions of P.L. 97-219 and P.L. 99-443.)

In FY 1986, 1987, and 1988, NSF's actual percentage for SBIR grants was 1.25 percent, as required under the provisions of P.L. 97-219 and P.L. 99-443.

And also on the evaluation of the energy—of the Engineering Research Centers that is being forwarded down to the National Science Board—if you would give us an indication of what criteria you use to evaluate that would be helpful.

Dr. **Phillips**. Just want to mention two things. One is that the—the federal agency small business research program in large part, I think, is modeled on the program started by NSF before the SBIR legislation was met—NSF had a program before that.

Also, I would, at the state level, Congressman—I think the Pennsylvania Ben Franklin Programs is, I think, far in the way the leader in the process of assessing the impact of these programs.

They have a great deal of documentation. The strong point is that they had their objectives clear at the outset when they began the program several years ago in '81; and their evaluation procedures are built around those initial objectives. They have spent money putting that evaluation process in place right at the beginning; and they have a lot to show for it right now.

Mr. **Walgren**. Maybe we ought to go look there.

Mr. Hayes?

Mr. **Hayes**. Dr. Phillips, here's a paragraph in here about the previous problems—I hope some were cleared up by the '82 legislation of antitrust regulations which were preventing some of the cooperative efforts.

Then there's a sentence in here that I don't understand. But just facing the alliances by foreign companies varies the example of the Massachusetts General Hospital, it's—German names are not my specialty but—Hoechst?

Dr. **Phillips**. Yes.

Mr. **Hayes**. Is balanced by our view of an individual collaborating program. What is the Massachusett's General program? Describe it to me. I did not see it referenced elsewhere. I know it exists; I do not know what it does.

Dr. **Phillips**. Yes, Hoechst is a German chemical company. Can't remember the exact year it started, in the early '80s; but, it began with Hoechst putting in, I think, something like $50 million for supporting research at Massachusetts General Hospital.

I think that was maybe for initially a 10 year period.

[A description of the program follows:]

DEPARTMENT OF MOLECULAR BIOLOGY

MASSACHUSETTS GENERAL HOSPITAL/HOECHST

In 1980, Howard Goodman approached Hoechst with the concept of creating a molecular biology department with talented researchers who need not be concerned with financial aspects of research. Goodman had been a consultant for Hoechst, and so, was familiar with this firm prior to submitting the proposal. He has no stock or other personal financial interest in Hoechst, however. Hoechst saw the 1980's as a decade to focus on biology and was anxious to expand its pharmaceutical operations. The firm wanted a "window on science."

Initially, Goodman tried to set up the new deparmtent at the University of California at San Francisco, where he was a member of the faculty. However, constraints in dealing with the vast University of California system, as a public institution, created difficulties in the negotiation process.

Massachusetts General Hospital (MGH) had independently decided to establish a Department of Molecular Biology and began 'courting' Goodman. Eight months after Goodman first approached Hoechst, the company signed an agreement with MGH for $70 million over a 10 period. Hoechst will provide a guaranteed minimum annual funding level that increases to $6 million per year in the last 7 years. Hoechst maintains the right to fund all additional research at the department. If the company does not exert this option, MGH may seek funding elsewhere provided the department does not accept funding from any other profit-making entity (without Hoechst's written consent). After the initial 10-year funding period, the agreement will be extended for additional 5-year increments unless either party requests termination by the end of the second year of each 5-year period.

Hoechst provides funding to MGH for basic research in a newly established Department of Molecular Biology. Research is focused on improved medical care using eukaryotic cell gene regulation, somatic cell genetics, microbial genetics, virology, immunology, and plant molecular biology. Research will be sponsored, but not directly, by Hoechst.

Initially, the Department was comprised of about 50 scientific and support employees. Staffing is expected to double. Like all MGH employees, investigators in the Department of Molecular Biology must sign a Participation Agreement adminstered by MGH's Office of Technology Administration. Under this Participation Agreement, employees agree to disclose inventions and to comply with procedures and policies on consultation and collaboration. Investigators in the Department are regarded as regular members of MGH staff; they are nominated for membership in the faculty of Harvard Medical School, and as appropriate, are recommended for tenure.

Hoechst can have up to four company scientists at any one time in the Department. The expectation is that these company scientists will return to Germany to head Hoechst's research laboratories. Time at MGH is therefore viewed as an important step in establising a career at the company.

The Joint Committee consists of three members of MGH's Board of Trustees and three senior executives from Hoechst. This group oversees the implementation of the agreement and serves as a forum for communication between MGH and Hoechst.

Department employees need not write grants as part of the peer evaluation process. MGH and Hoechst are aware that the lack of peer feedback and the loss of the discipline of grant writing may be a disadvantage of the arrangement. To compensate, evaluation by the Scientific Advisory Board Committee has been instituted. Senior investigators will prepare individual annual reports on the progress of their research including reprints of all scientific articles published during the year. These reports will be incorporated into Goodman's annual report of the Department to Hoechst.

The Scientific Advisory Board also reviews the performance of the Department and makes recommendations concerning work and operations. If the objectives are not being met in a satisfactory fashion, MGH must take steps to correct the situation, although obligations regarding support and operations of the arrangement will remain intact.

In addition, the Advisory Board evaluates the Department's annual report, prepared by Goodman, which includes progress reports by all senior investigators in the Department. The Advisory Board is currently made up of six scientists; two affiliated with and appointed by Hoechst, two scientists affiliated with and appointed by MGH, and two unaffiliated scientists, jointly appointed.

At least once a year, the Department will hold a 2 to 3 day symposium for invited academic participants to discuss research conducted at the Department. Hoechst may send employees and other individuals to the symposium, but will give the Department notice of the numbers of those attending. In addition, Goodman will report directly to Hoechst representatives up to three times a year. Senior investigators will confer with company representatives at least once a year.

The agreement is unusual in that Hoechst provides funds of approximately $18 million for renovation of a temporary facility, and for construction and equipment for a new facility to house the department. Renovating the initial space and building the new facility are being carried out in such a way that no third party (including the U.S. government) will be able to acquire rights or equity in any work accomplished solely in the Department by personnel of the Department. All equipment purchased through the agreement becomes property of MGH. Equipment can be transferred out of the Department upon payment of the fair market value to Hoechst. The Department will occupy 4 of the approximately 10 floors in the new building, the Wellman Research Building. The building, to be completed September 1985, will to be named after Arthur and Gullan M. Wellman, who have pledged $15 million to MGH for construction with what is believed to be the largest single contribution ever to an existing U.S. hospital.

MGH will submit manuscript drafts to Hoechst at least 30 days prior to submission for publication. If MGH and Hoechst agree to apply for a patent, applications will be the property of MGH. In return, Hoechst receives an exclusive world-wide license. If Hoechst does not begin commercial development within 3 years after the date of filing patent application, then the license becomes non-exclusive. If Hoechst does not wish to file a particular application, MGH can file for patent rights or release them to the inventor under limitations of the agreement. If MGH is not interested in filing, Hoechst is free to file in its own name.

Hoechst will pay MGH royalties for any license granted. Rates will be established in consideration of Hoechst's support for the research and the amount of royalties being paid on other licenses by Hoechst, but will not exceed 50 percent of the fair commercial royalty rate. In the event that an agreement on rates cannot be reached, the matter will be submitted to arbitration according to procedures of the American Arbitration Association. Royalties will be allocated among the inventor, the Department, the inventor's laboratory, and the general research funds of MGH in varying percentages. Proportions will shift from the inventor to the MGH general research fund as the amount of royalties increase. Royalty payments to the department are considered part of the total support guaranteed by Hoechst.

In research collaborations funded in part by Hoechst and in part by a third party, Hoechst's interest in obtaining exclusive world-wide licenses must be considered. Collaborations will entitle Hoechst to the most favorable license obtainable, at least a non-exclusive license. Arrangements will automatically take into account restrictions that the federal government may have in a collaboration.

The MGH Committee on Patents, which interprets and applies patent policy procedures for MGH, will oversee the Department's patent activity.

The Department received a great deal of public attention in 1980 because of the concern in establishing an alliance with a foreign partner. Apprehensions were expressed by the U.S. Government, and American and German institutions. The agreement has detailed consideration for patent policies, ownership, etc., in an effort to alleviate the concerns. Since the inception of the program, publicity and furor have subsided.

Mr. Hayes. Which I guess is pharmaceutical research?

Dr. Phillips. Yes, biomedical—biotechnology related to the pharmaceutical business at first.

And so that is a foreign company putting sizable dollars into a U.S. institution to support, by everyone's claim, fairly basic research.

And certain provisions that for a couple of Hoechst scientists each year to be able to work in the Massachusetts General; and, although I think that 50 million was for 10 years, after five years they are—some initial period—they were going to review the progress and then make a decision on extending the award.

Mr. Hayes. And that is a collaborative or non-collaborative program? Was there anyone—are they—is it a single company participation?

Dr. Phillips. Single company with a single institution. It is collaborative in the sense that—well, it's collaboration between the two institutions and working scientist.

Hoechst scientists spend time at Mass. General.

Mr. Walgren. But as the general deal, isn't it also the factor that there was some proprietary commitment where the German company would have certainly first dibs, if not exclusive dibs on developments.

And then, on top of that, there was a major federal research grant given to the institution. So at least on the surface, United States tax dollars were funding research which could directly lead to developments that only a German corporation could have the rights to commercialize.

Dr. Phillips. That was the initial concern. That was the concern when the agreement was first announced. And I think there were several hearings held by this committee.

And at least this full committee, I do not know—this subcommittee and maybe others on the program. I do not know the details of those hearings.

I gather some of those questions were satisfactorily answered, at least at that point. It was at one set—it was the fact that most of the—probably all the investigators involved in the program at Mass. General are or have been supported by the National Institutes of Health, and they still can be.

There is no restriction to that. That is, the continuing concern about the foreign participation is how does that relate to U.S. investments in that research.

And what I meant by—in the sense it is somewhat a confusing balance—is that it turns out, in this other institution that is carrying out research with funds provided by industry—that particular institution, although it's not a written policy, does not accept investments from any foreign company.

And then the next question comes up—what is the definition of a foreign company? And then it gets—the complexity increases.

Mr. **Hayes**. And that is when you need Buechner back in private. [Laughter.]

My other question was one that I do not know if John knows the answer to, but since I get to ask questions I do not know the answer to it seems only fair.

We are talking about student support as National Science Foundation programs. We are saying one of the effective ways to transfer technology is to send the graduate students who are freshly trained.

Does anyone keep the numbers on NSF graduate students—where they go? Where the—do percentage of those in the national lab, universities, and private industry—break down roughly where they go?

Dr. **Moore**. Yes, there is a tracking of doctorate students that is actually conducted under our general auspices by the National Academy of Sciences.

Mr. **Hayes**. Off-hand?

Dr. **Moore**. Not off-hand.

Mr. **Hayes**. I am not trying to put you on the spot. I would be most interested—it seems to me to be a guide to an assessment of—I know it is in physics.

It is—I do not know if physics is representative. When we were in—I went Friday; I got taught a good lesson. That's connect field hearings.

If you are not predisposed to have to run to the bathroom often you'd learn some things. In physics, this country has received 47 of 131 nobel prizes in physics. That's astounding; that's over a third.

And yet, a follow-up study at University of Iowa shows that only 5 percent of the graduate students associated with those programs ever went to private industry.

It ended up with 70 plus at the universities; 20 plus at national laboratories. I find that amazing. And I hope that that is an exception and not a rule. But I would be most interested in looking at the numbers.

And I sure want to chat about it with our panel in business coming up later.

Thank you. That is all.

Mr. **Buechner**. Mr. Chairman, ask one more—one question here of Dr. Moore.

I know there is a move in the small business community to increase the small business set-aside up to 3 percent of R&D agency's budget.

Could you just briefly say what impact that would have on NSF's current industry-university programs?

Dr. **Moore**. Well, it would be—first of all, it would be very difficult for us to—in other ways—to sustain that kind of increase.

We had just come—this is especially kind of a bad time to ask me that question, I guess, because we just got through the—through the 1988 budget compromise.

And NSF came off with—in the research account which is where this would come from—the Research and Related Activities account—a 3.3 percent increase for '88 over '87, which, of course, in constant dollar terms is a decrease.

And it leaves us with our research budget for 1988—current fiscal year—at the same level in constant dollar terms as it was in 1985.

So to carve another 1.75 percent out of that research budget I think would be very, very hard for us to do. I myself—my horseback opinion would be that that would be a mistake.

Mr. **BUECHNER**. Right.

Dr. **MOORE**. We would be taking money away from some extremely important research if we were asked to do that.

Mr. **BUECHNER**. Thank you, Mr. Chairman.

Mr. **WALGREN**. Dr. Phillips, you indicated in your testimony that there was some developing resistance on private industries' part to increase their participation or to continue down this road.

Those were just straws in the wind? Is there any elaboration you can give on that?

Dr. **PHILLIPS**. I was just saying that the—I do not think it is because of industry views of dissatisfaction with collaboration with universities, but more a comment about industrial research budgets—in most industries relatively small; and that the funds for these university programs come out of those already in small budgets; and for factors totally unrelated to universities, there's lots of constraints on those industrial research budgets lately.

And so it's hard to know what the future is going to hold. It relates to the whole competitive aspect of the industry and what's happening to material—particular products within that industry, so that most industry commentators that we have talked to, they do not expect the 5, 6, 7 percent to go to double—in general, across the board.

At some schools—Carnegie Mellon, which you know well, is one. It is well over 20 percent right now.

Mr. **WALGREN**. Certainly in basic research we rely by and large on government dollars for support, is that correct? What percentage of national basic research effort is supported by public funds on the one hand versus private sector funds on the other?

Dr. **MOORE**. Two thirds to three quarters.

Mr. **WALGREN**. So three out of four dollars, on basic research are public funds. And it would be a mistake to believe that this is not one of those areas that we ought to get doubling off our back, and see what happens.

Dr. **MOORE**. I think because of the nature of basic research—and that is that it—the benefits of basic research are widely available to many people—people besides the performer of that research.

You cannot expect industry to pick out a much larger share of that.

Mr. **WALGREN**. Well, all right. Well, thank you both. Let me see if there's something—okay, sure. We want to express our appreciation to and look forward to those submissions and see if, informally, in Washington, as we do from time to time, and particularly with the NSF hearings coming up—I know we'll probably see both of you, in view of what the National Academy of Sciences—their perspectives are on what you folks are doing.

So we appreciate your participation here. And we'll see you soon.

Dr. **Moore**. Thank you.

Dr. **Phillips**. Thank you, Congressman.

Mr. **Walgren**. Let's take a brief break here because we apparently have to assemble another table to accommodate the number of witnesses on the next panel.

[Recess.]

Mr. **Walgren**. Okay. Let's have the next group—Dr. Michael Montague, who is representing Monsanto; and I'm sorry to say Dr. Schneiderman today—we understand Dr. Schneiderman is ill; and we hope that he has a speedy recovery. I'm looking forward to hearing from him some time soon—either in Washington or otherwise.

But the—Dr. Montague is joined by Ross Spicer, the President of Southwestern Bell Company Technology Resources Incorporated; Dr. Donald Ames, the General Manager of McDonnell Douglas, Research Labs; and Rick Srigley, Executive Vice President, Chief Operating officer of Invitron—is that the right pronunciation?

Well, we appreciate your coming. And we will just go—in the order in which I've introduced you into the record.

Please feel free to underscore the points that you would like to stand out in the record. And I'm sorry that we're falling a little bit behind. But we have time for the points that you feel are important.

So let's start with Dr. Montague.

STATEMENT OF DR. MICHAEL J. MONTAGUE, MANAGER, OPERATIONS, BIOLOGICAL SCIENCES, MONSANTO CO.

Dr. **Montague**. Thank you, Mr. Chairman. I am Michael J. Montague, Manager of Operations for the Biological Sciences Department at Monsanto Company which is headquartered here in St. Louis, Missouri.

It is a privilege to address the Subcommittee on behalf of Dr. Schneiderman.

Let me begin by noting the following point. Our nation's economy is undergoing a rapid change from a resource based to a knowledge based economy.

Let me see if I can clarify that point by citing an example.

In agriculture, it is the knowledge of the farmer, not the total number of acres that he cultivates that determines his success.

And here I define success as profitability and competitiveness in the world marketplace.

Our nation's industry can remain the leading productive economic force in the world only by remaining on the leading edge of technological change.

In other words, either you must be an innovative company, or you will compete with a company in Japan, Korea, France or elsewhere, which is innovative.

We in the United States must find new, better, creative ways to remain at the cutting edge of technology.

One way to enhance industrial competitiveness is to couple the talents of America's research driven companies with those of America's research universities.

To explain how this might be done, I will go out in the experience of my own company, Monsanto Company.

Last year, Monsanto spent $645 million on research, of which between $15 and $20 million was spent on university research collaborations and research partnerships.

Let me emphasize that these are truly partnerships in discovery research—that is, fundamental basic research, not partnerships in the development of products. That is the critical distinction.

We encourage the universities to do what they do so very well—that is, make discoveries. All scientists in these partnerships work fully with the university scientists so that they work together in the discovery arena, each sharing in that discovery process.

But then, on our own we develop these discoveries into new products that benefit people and fuel the economy.

Our largest research project is with the Washington University Medical School. This joint discovery program has had wonderful consequences already for both institutions.

We are convinced beyond doubt that all our research collaboration with Washington University accelerates the rate at which fundamental discoveries in the biomedical sciences are translated into actual products that cure disease.

In fact today five new therapeutic products, based on our discovery partnership with Washington University, are being developed by G.D. Searle, which is Monsanto Company's fully owned pharmaceutical subsidiary.

Well, how does the partnership work? What are the administrative details of this partnership that make it successful?

First of all, funds are administered by a committee of scientists drawn from both institutions; and research proposals from a medical school are judged on the scientific merit of the research just as we would do with federal grant proposals.

Second, the university owns the patents on its discoveries and Monsanto retains exclusive licensing privileges.

Third, publication of a discovery that important product of the university—the publication—is never delayed more than 30 days.

This is a critical commitment on the part of Monsanto Company so that fundamental research is not hindered.

And finally, Monsanto does not direct the university's research. Academic freedom is preserved. To do otherwise would not be in the best interest of either institution, because it would subvert the basic missions of each institution.

Incidently, I should add that industry-university collaborations may not be appropriate for every university department or for every company.

There is no generic format that would work for everyone and every place. Each partnership, like every human relationship, must be handcrafted and carefully worked out.

A successful relationship demands openness and give and take.

Another issue important to consider involves the possible limitation on foreign companies in formulating similar partnerships with our universities here in the United States.

In most cases I believe that it would be a mistake to limit the involvement of foreign companies in such partnerships.

But—and this is a critical—but we must insist on reciprocity—equal access for America's scientists, engineers and companies to the best research in the engineering centers of other countries.

To conclude, if the United States is to remain the leading economic power in the world, it must position itself on the leading edge of technology.

Two of America's strengths have always been innovation and invention. There is no more fertile ground for invention than at the interface between America's great universities and her industry.

Let us continue even more to harvest the fruits of this partnership. Thank you.

Mr. **WALGREN**. Thank you, Dr. Montague.

Mr. Spicer.

Mr. **SPICER**. I am delighted to be here.

Mr. **WALGREN**. Good to have you.

STATEMENT OF ROSS SPICER, PRESIDENT, SOUTHWESTERN BELL COMPANY TECHNOLOGY RESOURCES, INC.

Mr. **SPICER**. I am President of SBC Technology Resources, Incorporated, which is a subsidiary of Southwestern Bell Corporation, and specializes in technology planning and applied technology.

The decision to go ahead with the technology organization was made on April of last year; and the separate subsidiary, by the way, was just formed as of February 1.

In the time I have I would like to discuss Southwestern Bell Corporation's technology resource functions, and how we plan to make university relations and cooperation a part of our technology action plan.

I am going to try to, as you suggested, skip over some things that you are already familiar with.

I think, as most everybody's aware of, Southwestern Bell Corporation is one of the largest telecommunications companies in the United States.

And at divesture of the Bell System some four years ago, we became one of seven Bell Regional Holding Companies. Our headquarters is in St. Louis.

And as all regions have changed, we have changed in the last four years. Our principle subsidiaries are Southwestern Bell Telephone Company, which is the normal telephone company which provides service to 11 million access lines—Arkansas, Kansas, Missouri, Oklahoma and Texas.

We have Southwestern Bell Publications, the nation's largest publisher of telephone directories with products in 46 States; and we have Southwestern Bell Mobile Systems, which after assimilation of the MetroMedia cellular properties, which you all were familiar with, an acquisition we made, provides cellular mobile telephone service to 21 metropolitan areas, including four of the top ten.

And we also have MetroMedia Paging Services, a major provider of state of the art paging services in 30 markets, including nine of the ten largest metropolitan areas with 620,000 pagers.

And finally we have a Southwestern Bell Telecom which is in the telecommunications equipment market place.

The mission of our subsidiary is to provide technology resources that will position Southwestern Bell Corporation as the quality provider of leading-edge communications products and services at competitive prices.

I am not going to resay our goals. Our Applied Technology group will be responsible for development and application of technology innovations.

To accomplish these activities we have included university liaisons as part of our plan.

In fact, our objective corporately is to exploit technology rather than develop a lot internally. So our idea is to have a first rate internal organization that may do some applied technology work, but primarily exploit our efforts to the use of universities and other affiliations.

Working with universities, our technologies will broaden their understanding of developments and emerging technologies. We are extremely proud of the fact that in Southwestern Bell territory there are 19 such universities which offer a doctoral degree in either electrical engineering or computer science.

And as you all are familiar, we have industrial liaison programs just like everybody else does; and we also have specific contracts.

And we currently have a contract with Washington University in the Department of Computer Science where we are studying high speed data communications, and we expect to do more of that in the future.

We do, as you all are aware, have some limitations that stand in our way and affect our ability to conduct research activities both internally and through universities.

And I would like to point out that many of the traditional research and development functions are not available to us. As a Bell Regional Holding Company we are restrained by the Federal Court from certain design and development activities which have been interpreted as part of manufacturing.

For instance, we cannot design or develop telecommunications equipment used to transmit communications over a network—even the most basic telephones used by our customers.

We applaud the efforts of Congress to ease these restrictions on the design and development imposed by the Court. If the restrictions are limited our activities with the universities can be greatly expanded.

I also—and surely you are all familiar with the Tax Code on the difference between basic and applied research. We get 100 percent tax credit on basic, and only 6 percent on applied.

We think if that was changed it would, again, let us spend more money in the research area.

And I was very fascinated by our friend from Monsanto's statement about knowledge. And the way I remember your statement; I'd like to take a statement that I often quote that says, "The capacity to use knowledge has long since replaced both ownership and political fiat as the source of economic power."

And finally, to take just an extra minute, the Chairman of our company, Sam Barnes was, late January, in Washington speaking before the Communications network conference that they had there.

And I would like to just take a minute and quote from some of the things he said that relate to the problem with being competitive worldwide from the telecommunications standpoint.

He made the statement as follows. "We must not wait for a crisis in communications like the stock market's black Monday's disaster before we take action to put America's telecommunications system back on the fast track," Barnes said.

If America is to retain its position as the premier world power in telecommunications, our leaders must create a regulatory framework that allows maximum competitive flexibility while protecting consumer interest.

Barnes said that the main road block separating modern telecommunications services and consumers are restrictions placed on the former Bell Operating Companies by the U.S. District Court which oversees the consentry that broke up the Bell System.

I believe it is proper with a court to decide matters involving anti-trust. However, there are issues of public policy here that go beyond the jurisdiction of the Federal Court Judge—issues of competitors, trade, technology and consumer benefit.

For the industry to be competitive and bring new services and technologies to the consumer, Barnes said, "there must be an end to the Court ordered bans on the block provision of long-call long distance service, information service, and equipment manufacturing and design."

"Support for these changes are growing in the Reagan Administration and in Congress," Barnes added, "I think our leaders are increasingly questioning the logic in a national regulatory scheming that allows telecommunications companies to manufacture toys but not telephones that give seven leading companies the right to manufacture and sell communications equipment in Thailand but not Tennessee."

And finally, on the balance of trade, I was reading the other day where, I think, six, seven years ago our balance of trade in the telecommunications area was a positive half a billion dollars; and today I understand it's two and a half billion dollars negative.

Thank you.

[The prepared statement of Mr. Spicer follows:]

TESTIMONY OF ROSS SPICER, PRESIDENT SBC TECHOLOGY RESOURCES, INC., A SUBSIDIARY OF SOUTHWESTERN BELL CORP.

Good morning, Mr. Chairman and members of the subcommittee.

My name is Ross Spicer. I am President of SBC Technology Resources, Inc. Technology Resources is a subsidiary of Southwestern Bell Corporation and specializes in technology planning and applied technology.

I would like to commend this subcommittee for its concern for the issues surrounding university-industry interaction.

In the time I have this morning, I'll discuss Southwestern Bell Corporation's technology resource functions and how we plan to make university relations and cooperation a part of our technology action plan.

By way of introduction, Southwestern Bell Corporation is one of the United States largest communications companies. At divestiture of the Bell System some four years ago, we became one of the seven Bell Regional Holding Companies. Our headquarters is in St. Louis, Missouri.

Today, our principal subsidiaries are:

Southwestern Bell Telephone, which provides telecommunications service to nearly 11 million access lines in our five-state territory which includes Arkansas, Kansas, Missouri, Oklahoma and Texas;

Southwestern Bell Publications, the nation's largest publisher of telephone directories with products in 46 states;

Southwestern Bell Mobile Systems, which after assimilation of the MetroMedia cellular properties, will provide cellular mobile telephone service to 21 metropolitan areas, including four of the top ten;

Metromedia Paging Services, a major provider of state-of-the-art paging services in 30 markets including nine of the 10 largest metropolitan areas with 620,000 pagers currently in service;

And, Southwestern Bell Telecom, a leading competitor in the telecommunications equipment marketplace with business communications systems installed in 26 states and consumer products sold in 12,000 retail outlets and soon in the United Kingdom.

The mission of our subsidiary is to provide technology resources that will position Southwestern Bell Corporation as the quality provider of leading-edge communications products and services at competitive prices.

Our goals are clear cut:

To understand the business needs of our subsidiaries and identify required technologies.

To evaluate worldwide technology developments, determine impacts on our corporation and formulate responses.

To optimize the external/internal transfer of technology.

And, to prioritize and direct corporate technology resources to those areas that support subsidiary growth strategies and cost reductions.

We have taken a two-pronged approach to addressing our technology needs. Our organization is divided into a technology planning group and an applied technolgoy group.

Our Technology Planning function will identify and prioritize areas where technology efforts should be focused. They will work with our corporate marketing function to select projects which will ensure that desired payoffs are achieved.

Our Applied Technology group will be responsible for the development and application of technological innovations.

To accomplish these activities, we have included university liaisons as a part of our plan. The purpose of our involvement with universities is to support two of our organization's four goals.

These relationships will affect the evaluation of worldwide technology developments, determination of impacts, and formulation of responses and the optimization of external and internal transfer of technology.

Working with universities, our technologists will broaden their understanding of developments and emerging technologies. And, alliances will also serve to leverage the resources available to our corporation.

Our university plans are targeted at two sectors. We plan to establish relationships with the best universities across the United States in our chosen fields. Secondly, we plan to establish alliances with selected major universities located in the five state territory of Southwestern Bell.

We are proud of the fact that there are 19 such universities which offer a doctoral degree in either electrical engineering or computer science.

For our relationships with universities, we plan two types of involvement: Industrial liaison programs, which will allow us access to a number of areas of interest in each university. And, specific contracts, which will enable us to pursue individual, proprietary studies for our benefit exclusively.

Our corporation stands to benefit in other ways from these associations, as well. Our employees will gain valuable education and we hope to benefit in the area of recruiting.

Already we have begun utilizing the resources of universities. For example, we have contracted with the Department of Computer Science at Washington University in St. Louis for a study of high speed data communications. The culmination of this study will be a detailed project plan for a set of experiments in high bandwidth digital communications.

We do have some limitations that stand in our way and affect our ability to conduct research activities, both internally and through universities. I would like to point out that many of the traditional research and development functions are not available to us.

As a Bell Regional Holding Company, we are constrained by the Federal Court from certain design and development activities. For instance, we cannot design or develop telecommunications equipment used to transmit communications over our network or even the most basic telephones used by our customers.

We applaud the efforts of Congress to ease these restrictions on design and development imposed by the Court. If the restrictions are lifted, our activities with universities can be greatly expanded.

I also would like to offer the following suggestions concerning the research tax credit. These changes, in our opinion, would help promote interaction between universities and industry.

We would like to see the research tax credit as defined in Section 41 of the Internal Revenue Code of 1986 extended beyond the 1988 tax year.

While we applaud the improvement in the credit provided by the 1986 Tax Act, all research performed under contract by a university—both basic and applied—should be included in the definition of qualified expense and should be calculated at 100 percent. Currently, we may use 100 percent of the expense of basic research done by a university in our tax credit calculations, but only 65 percent of the expense of applied research.

We would also like to see the amount of the credit increased in order to benefit United States technology. However, we realize this increase has to be tempered with budget deficit concerns.

These changes would permit Southwestern Bell Corporation to better utilize the resources available in America's universities.

Thank you for giving me the opportunity to share our views on this issue.

Mr. **Walgren**. Thank you, Mr. Spicer, very much. And we'll turn to Dr. Ames.

STATEMENT OF DR. DONALD P. AMES, GENERAL MANAGER, McDONNELL DOUGLAS RESEARCH LABS, ST. LOUIS, MO

Dr. **Ames**. Mr. Chairman, Congressman Buechner, Congressman Hayes. I am the General Manager of the corporate research laboratories at McDonnell Douglas.

And I have a statement prepared here. And in the interest of time I will shorten this up.

McDonnell Douglas Corporation has collaborated with universities since the early 1960s. This cooperation includes financial support in the form of endowed chairs, building fund and general fund contributions, scholarships and corporate affiliate programs.

During the past ten years, McDonnell Douglas Corporation has funded numerous small collaborative research programs with many U.S. universities.

The reports of this collaborative research have been included in the annual research and development reports to the Department of Defense and the National Aeronautics and Space Administration.

You should note that that report is a requirement.

Now I am going to focus on the questions that you ask in your letter which was addressed to the corporation.

The role of state government in fostering a university-industry cooperation. State government has a major role in fostering university-industrial cooperation through the funding mechanism.

Missouri House Bill 1375 passed on April 7, 1982 and amended in August 1985 provides one-third of the funding to any university in the state for a project approved by the Missouri Board of Curators.

The remaining two-thirds must be contributed by a source other than the state or Federal Government funding agency.

State-of-the-art facilities, plus a productive faculty are major ingredients for increasing cooperative academic industrial research.

It is imperative that the state government develop procedures to augment their federal support for instruments, computers, equipment and research laboratories.

Factors causing increase in such academic university cooperation.—Although industry performs substantial objective oriented research, it recognizes that it does not possess all the skills required.

M.D.C., McDonnell Douglas Corporation, encourages its scientists and engineers to open communication channels with academe to seek productive collaborations.

Constrained by obsolete equipment and facilities, the paucity of available graduate students, and limited grants and contracts, research-active faculty have turned to industry to obtain contracts and or access to state-of-the-art equipment and facilities.

Aerospace corporations utilizing independent research and development, IRAD funds, have been urged by DoD and NASA to seek academic collaborations to assist universities and to augment their IRAD programs.

Barriers to expanding cooperation.—There are no overwhelming impediments to control or dominate university-industry research relationships.

Given the incentive to enter a particular relationship on the part of both parties and adequate attention to resolve specific problems, the desired collaborations usually are attained.

The greatest academic concern regarding collaborative research is publication delays caused by the information protection desires of industry if a patent is required.

Since the information propriety is guaranteed for one year after publication, this barrier is not a major concern to industry.

The most significant impediment to collaboration for industry is a desire to perform the research in their laboratories where objectives and performance period can be controlled.

Another barrier involves patent rights and royalties. Industry requires license free use for any patent resulting from research which was performed completely by academe with industrial funds.

When a collaborative effort produces the patent, the industry requests an equal split of the royalties with the university; and the patent is jointly owned.

When a faculty member owns the patent outright, an opportunity denied to an industrial scientist, a morale problem occurs.

Consequently, industry recommends patent ownership by the university.

The final barrier is created by attitudinal factors. These factors include philosophy, objectivity, trust, suspicion of motives, and accomplishment-based respect—criteria that companies and universities should use in determining whether a partnership would be productive.

The criteria for pursuit of collaborative research include: one, identification of general and detailed objectives; two, estimated time for completion; three, location for the pursuit of each objective; four, identification and availability, and location of facilities for performing the work; five, cost estimates; six, identification of deliverables plus delivery date; seven, periodic progress reviews; and eight, resolution of all potential barriers.

When both parties know what to expect for a mutually agreed cost on a stated delivery date and who is to perform each work package, then a productive collaboration is highly probable.

Economic impact and cooperation at the state/national levels.—Two examples of success resulting from university-industry interactions are the Route 128 industries in Boston and the industries surrounding Stanford at Palo Alto.

The development of, and desire for, high technology industries and research parks in major U.S. cities is testimony for the economic impact of cooperation between industry and universities.

Evaluation period.—If the relationship involves a continuing program where project objectives do not perturb the research effort significantly, then one year is sufficient.

If the research effort requires major program modification to pursue the desired objectives, then two years should produce results.

How smaller companies can take advantage of University expertise.—Small companies located in the same geographic area as a major university can interact with faculty by scheduled or unscheduled meetings.

If a small company is not located near a large university, it can request the information on research programs from the Office of Small Business Research and Development at the National Science Foundation.

The role of the U.S. government and its agencies in university research involving foreign universities, companies and nationals.—

There are regulations. Those regulations are quoted in my testimony here. And I will only read the conclusions. Current regulations are written with general definitions and are subject to wide and varying interpretations.

American universities seem to be generally unaware of the regulations for controlling the export of sensitive technologies. And there is little government education or enforcement of existing regulations.

There appears to be a need to review current regulations to see if they can be more tightly written. Procedures need to be explored which will improve the understanding of these regulations within the academic research community.

Finally, procedures for stricter enforcement of these regulations need to be evaluated, developed and implemented.

Thank you.

[The prepared statement of Dr. Ames follows:]

PREPARED STATEMENT OF DR. DONALD P. AMES, GENERAL MANAGER, McDONNELL DOUGLAS CORP.

Research relationships between universities and industry have been important since the turn of the 20th century. The persistence of these relationships depend upon industry's requirement for highly qualified new scientists and engineers. In the 1980s, cooperation increased because of the scientific and technological successes of other countries, limited federal research and development budget for universities, and their need for new equipment and facilities. Additional impetus for cooperation has been provided by high technology requirements in industrial products and services coupled with limited industrial research and development capability. The National Science Foundation has stimulated this cooperation through the formation of Engineering and Science Research Centers at universities. Federal funding for these centers will decrease with time, whereas industrial funding will increase to reach a relatively constant budget.

McDonnell Douglas Corporation (MDC) has collaborated with universities since the early 1960s. This cooperation includes financial support in the form of endowed chairs, building fund and general fund contributions, scholarships, and corporate affilated programs. During the past ten years, MDC has funded numerous small collaborative research programs with many U.S. universities. Reports of this collaborative research have been included in annual research and development reports to the Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA). This effort has contributed to the stature of MDC with DoD and NASA. Additional corporate collaboration occurs by employing 1) faculty as part-time employees, as consultants, and during sabbatical terms, and 2) graduate and undergraduate students as parttime employees, summer interns, and permitting them to perform on-site advanced degree studies. Exchange seminars with universities are routine and have the objective of opening communication channels to search for future collaborative efforts. Close cooperation of industry and universities is indispensable for the efficient creation and transfer of new knowledge and to better train future MDC employees in required critical disciplines.

FOCUS OF HEARING

1. *The role of the State Government in Fostering University-Industry Cooperation.—*

State government has a major role in fostering university-industrial cooperation through the funding mechanism. Missouri House Bill 1375 passed on April 7, 1982 and amended in August 1985 provides one-third of the funding to any university in the state for a project approved by the Missouri Board of Curators. The remaining two-thirds of the funds must be contributed by a source other than a state or federal government agency. This bill has been the major stimulus for academic-industrial cooperative projects involving Missouri universities. Under this bill, industry outside of Missouri benefits.

State-of-the-art facilities plus a productive faculty are major ingredients for increasing cooperative academic-industrial research. It is imperative that the state government develop procedures to augment Federal support for instruments, computers, equipment, and research laboratories. Currently research-active faculty must compete nationally for the limited Federal funds for such facilities. State government should designate a portion of its university budget for facilities other than buildings. These funds are needed for equipment required for research in emerging technologies.

2. *Factors Relating to Increasing Interest, Barriers, and Productivity of University/Industry Cooperation.—*

2.1 *Factors Causing Increasing Interest in Such Cooperation:*

U.S. industry is determined to strengthen its competitive position in the world market. Although industry performs substantial objective-oriented research, it recognizes that it does not possess al the skills required. If properly motivated, universities could augment their research efforts through industry collaboration. MDC encourages its scientists and engineers to open communication channels with academe to seek productive collaborations.

Constrained by obsolete equipment and facilities, the paucity of available graduate students, and limited grants and contracts, research-active faculty have turned to industry to obtain contracts and/or the access to state-of-the-art equipment and facilities. Industry now finds academic scientists willing to perform research on objective-oriented projects, thereby increasing productivity.

Aerospace corporations utilizing Independent Research and Development (IRAD) funds have been urged by DoD and NASA to seek academic collaborations to assist universities and to augment their IRAD programs. In fact, some lead DoD/NASA laboratories request a report of university-industry collaboration with the required annual IRAD Report.

2.2 *Barriers to Expanding Cooperation:*

There are no overwhelming impediments to control or dominate university-industry research relationships. Given the incentive to enter a particular relationship on the part of both parties and adequate attention to resolve specific problems, the desired collaborations usually are attained.

The greatest academic concern regarding collaborative research is publication delays caused by the information protection desires of industry if a patent is required. Since the information propriety is guaranteed for one year after publication, this barrier is not a major concern to industry.

The most significant impediment to collaboration for industry is a desire to perform the research in their laboratories where objectives and performance period can be controlled. This realistic barrier occurs only when time is a constraint and similar facilities and/or capabilities exist.

Another barrier involves patent rights and royalties. Industry requires license free use for any patent resulting from research which was performed completely by academe with industrial funds. When a collaborative effort produces the patent, then industry requests an equal split of the royalties with the university, and the patent is jointly owned. When a faculty member owns the patent outright, an opportunity denied an industrial scientist, a morale problem occurs. Consequently, industry recommends patent ownership by the university.

The final barrier is created by attitudinal factors. These factors include philosophy, objectivity, trust, suspicion of motives, and accomplishment-based respect. Open to question is whether these factors are root causes or symptomatic reflections of other unidentified barriers.

2.3 *Criteria That Companies and Universities Should Use in Determining Whether a Partnership Would Be Productive:* The criteria for the pursuit of collaborative research include (1) identification of general and detailed objectives, (2) estimated time for completion, (3) location for pursuit of each objective, (4) identification, availability, and location of facilities for performing work, (5) cost estimates, (6) identification of deliverables plus delivery date, (7) periodic progress reviews, and (8) resolution of all potential barriers. When both parties know what to expect for a mutually agreed cost on a stated delivery date and who is to perform each work package, then a productive collaboration is highly probable.

3. *Economic Impact and Evaluation Period for University/Industry Relationships.—*

3.1 *Economic Impact of Cooperation at State and National Levels.* Two examples of success resulting from university-industry interactions are the Route 128 industries in Boston and the industries surrounding Stanford at Palo Alto. The development of, and desire for, high technology industries and research parks in major U.S. cities is testimony for the economic impact of cooperation between industry and universities.

3.2 *Evaluation Period:* If the relationship involves a continuing program where project objectives do not perturb the research effort significantly, then one year is sufficient. If the research effort requires major program modification to pursue the desired objectives, then two years should produce results.

4. *How Smaller Companies Can Take Advantage of University Expertise.*—Small companies located in the same geographic area as a major university can interact with faculty by scheduled or unscheduled meetings. In addition, these companies can employ part-time graduate students or faculty to incorporate research into their products. If the small company is not located near a large university, it can request information on research programs from the Office of Small Business Research and Development at the National Science Foundation in Washington, D.C. This office will refer the small company to appropriate faculty who are performing relevant research.

5. *Role of U.S. Government and Its Agencies in University Research Involving Foreign Universities, Companies, or Nationals.—*

5.1 *Existing Regulations* (selected data): The export of classified technical data, i.e., technical data that has been assigned a security classification (e.g., TOP SECRET, SECRET, or CONFIDENTIAL) by an officer or agency of the U.S. government is controlled by the U.S. Department of State or U.S. Nuclear Regulatory Commission. Export of unclassified technical data is controlled by Export Administration Regulations—U.S. Department of Commerce, Export Administration.

5.1.1 *Department of State:*

(a) Technical Assistance agreements: Technical Assistance agreements are required for disclosure of technical data (CFR 120.2). Technical data includes information in the form of plans, computer software, and documentation associated with the design, engineering, development, and production of defense articles. However, technical assistance agreements are not required for "information concerning general scientific, mathematical or engineering principles."

(b) Exemptions of general applicability (CFR 125.4): One of the exemptions concerns the disclosure of technical data in the U.S. by U.S. institutions of higher learning to foreign persons (none of the exemptions apply to exports to proscribed destinations). This exemption is available only if (1) the employee's permanent abode throughout the period of employment is in the United States, (2) the employee is not a national of a country to which exports are prohibited pursuant to para. 126.1, and (3) the institution informs the individual in writing that the technical data may not be transferred to other foreign persons without the prior written approval of the Office of Munitions Control.

(c) Advisory Opinions (CFR 126.9): Any person desiring information as to whether the Office of Munitions Control would be likely to grant or deny a license for export may use the informal "Advisory Opinions" procedure. All requests must be in letter form. The Department of State specifically states that such opinions are nonbinding on the D.O.S.

5.1.2 *U.S. Department of Commerce:*

(a) License to export (EAR 379.2): An export of unclassified technical data must be made under either a U.S. Department of Commerce general license or a validated export license. General licenses "GTDA" and "GTDR" apply to specific types of exports of technical data. A validated license is required for any export of technical data where the aforementioned general licenses do not apply.

(b) General License GTDA (EAR 379.3): The general license designated GTDA is used to authorize the export of technical data in several categories, including scientific or educational data. This category covers all academic institutions and laboratory data except information that involves research under contract related directly and significantly to design, production, or utilization in industrial processes.

EAR 379.3 also provides for the unrestricted export to any destination of information arising during or resulting from fundamental research. "Fundamental research" means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons. Paragraphs (c) (2) through (4) of this section provide explicit rules to identify research qualifying as "fundamental research." This section also states the conditions under which university-based research would normally be considered "fundamental research."

5.2 *Observations:* The following comments on current practices are based on conversations with persons involved in or associated with U.S. universities and their research for and with foreign countries, their entities, or nationals.

5.2.1 University faculty involved in contract/grant research are generally not well informed (if at all) about pertinent laws and regulations designed to protect sensitive technologies.

5.2.2 Their experience and that of others indicates that the relevant USG agencies do a very poor job of informing educational institutions of the laws and regulations that pertain to contract research done for foreign entities. It is arguable that some, if not all, agencies make no effort whatsoever to educate universities in this regard.

5.2.3 A significant increase has been observed recently in requests for research work from a variety of foreign companies. One source interviewed specifically mentioned Japan as a major source of increased business.

5.2.4 When asked what procedures universities follow to insure compliance with the various laws and regulations attendant to foreign contracts, the sources interviewed stated that, to a significant degree, those directly involved in research were unaware there were any limitations. Research administration offices simply forward contracts with no comment whatsoever about any USG limitations.

5.2.5 A large number of foreign graduate students are involved with sensitive technologies. This occurs in an atmosphere of relatively free exchange of data, software, and procedures with many of these students returning home upon completion of their degree programs.

5.3 *Conclusion:*

Current regulations are written with general definitions and are subject to wide and varying interpretations. American universities seem to be generally unaware of the regulations for controlling the export of sensitive technologies and there is little government education or enforcement of the existing regulations.

U.S. universities are currently conducting research with foreign companies and universities. Foreign graduate students are participating in this research and in similar research for U.S. companies. The research is being conducted with little knowledge of the regulations which control the export of technical data. A concern is that, under current circumstances, research data and knowledge that would not be granted export licenses may be leaving the U.S. To the extent that this situation is occurring, it is to the detriment of U.S. industry and jobs, and, in the worst case, may be impacting national security.

There appears to be a need to review current regulations to see if they can be more tightly written. Procedures need to be explored which would improve the understanding of these regulations within the academic research community. Finally, procedures for stricter enforcement of these regulations need to be evaluated, developed, and implemented.

DONALD P. AMES

Position: General Manager-McDonnell Douglas Research Laboratories (MDRL), MDC Distinguished Fellow.

Education: 1949, Ph.D. Physical Chemistry, University of Wisconsin; 1944, B.S. Chemistry, University of Wisconsin.

MDC Experience: Since 1971 Dr. Ames has been accountable for the objective-oriented research conducted by MDRL.

1961-1970. Dr. Ames directed and conducted objective-oriented research in low-temperature and microwave physics.

Other Experience: 1956-1961. As a Research Chemist and Scientist for Monsanto, Dr. Ames worked on developing gas-liquid chromatographs, measuring particle-size distribution, and nuclear resonance spectroscopy.

1954-1956. At DuPont's Savannah River Laboratory, Dr. Ames worked on solvent-extraction-process chemistry of uranium, plutonium, and thorium.

1952-1954. As an Assistant Professor in Physical Chemistry at the University of Kentucky, Dr. Ames worked on ionic conductances in nonaqueous solutions.

1950-1952. At Los Alamos Scientific Laboratory, Dr. Ames worked on determining fission products, bomb yields and efficiencies, and the disintegration schemes of short-lived fission products.

1946-1950. At the University of Wisconsin, Dr. Ames studied the kinetics of isotopic exchange between sulfur-containing anions.

1944-1946. While in the Special Engineering Detachment Corps of Engineers, U.S. Army, Dr. Ames worked on the solution chemistry of Ra, U, Np, Pu, and determined the half-life of ^{226} Ra by alpha counting.

Memberships and Honors: Dr. Ames is a member of the Combustion Institute; American Physical Society and its Chemical Physics, High Polymer and Solid State Divisions; American Chemical Society and its Physical Chemistry and High Polymer Divisions; Society of Engineering Science; Sigma Xi (honorary research society); Phi Eta Sigma, Phi Beta Kappa, Phi Kappa Phi and Phi Lambda Upsilon (academic honorary societies); Missouri Academy of Science; American Institute of Physics Advisory Committere on Corporate Associates, 1977-1980 and 1982-1985. He received an Honorary Doctor of Laws Degree from the University of Missouri-St. Louis in May 1978 and is Listed in Who's Who in America, 42nd through 44th Editions, 1982-1987, and American Men & Women of Science, 9th (1955) thorugh 16th (1984) editions.

Publications: Dr. Ames has authored or co-authored 37 scientific papers in the journals of discipline societies.

Mr. **WALGREN**. Thank you very much, Dr. Ames.

Mr. Srigley.

Mr. **SRIGLEY**. Thank you.

STATEMENT OF RICK SRIGLEY, EXECUTIVE VICE PRESIDENT AND CHIEF OPERATING OFFICER, INVITRON, ST. LOUIS, MO

Mr. **SRIGLEY**. Thank you, Mr. Chairman, Congressman Buechner, Congressman Hayes and members of the staff.

My name is Rick Srigley. I am Executive Vice President and Chief Operating Officer of Invitron Corporation located here in St. Louis—thank you.

I would like to convey my appreciation for the opportunity to address the subcommittee on a topic of great interest to companies such as ours, and a great interest to the United States.

Invitron was formed as a result of a partnership between Monsanto Company and Moshe Alafi, an individual who has been dynamically involved in the start up of a number of successfully—successful technology based companies.

Since its inception just three years ago, Invitron has grown rapidly. We now have nearly 200 employees and are one of the world's leaders in the manufacture of pharmaceuticals resulting from biotechnology.

We are, however, still in a tenuous stage of our development. This subcommittee has heard testimony this morning from a number of organizations.

My participation is that of a representative of a small technology based company. Invitron has two major areas of endeavor.

The first is a manufacturer of biological pharmaceuticals for a broad mix of companies encompassing established pharmaceutical houses, as well as the burgeoning biotechnology industry.

We are developing a strong international business base. Approximately one third of our clients are European or Japanese companies.

Our second area of interest is in the development of the number of potentially important products in collaboration with other companies or academic institutions.

These include second generation tissue plasminogen activator; a parathyroid imaging antibody; recombinant Factor VIIIc for the treatment of hemophilia; and a novel—and a number of novel, naturally-occurring products such as these.

These programs are in various stages of development. Two evolve from collaborations with other companies. The rest came about as the result of collaborative research with scientists at several universities.

Invitron is a research intense organization. In 1987 we spent 34 and a half percent of our total expenses—over $3.4 million on research and development.

A significant percentage of those expenses were related to outside collaborations with U.S. academic institutions.

In his remarks, Dr. Moore mentioned the Small Business Innovative Research program. We have been fortunate in that several of our collaborations have qualified for grants under the SBIR program.

In our experience this is an example of a federal program which works well and accomplishes its intended mission. While we are occasionally dismayed by the amount of time and internal resources necessary to apply for and maintain the grants and the timing restrictions imposed on the research by the mechanics of the grant process, we are hearty advocates of the program.

In the two years that we have been participants, the program has assisted us to support the work of top local scientists at Washington University and the University of Kansas.

In the past year we have submitted several additional SBIR applications which, if funded by NIH, will provide financial assistance to support work of scientists at Northwestern University, as well as continued work with Washington University.

The cooperation which exists today between researchers in universities and industrial organizations is unprecedented, not only in its scope but also in its spirit.

We believe that the SBIR grant program is a clear example of how the Federal Government can encourage closer ties between industrial and academic researchers and directly benefit both.

We intend to continue and, if possible, broaden our participation in that program.

A second way in which the Federal Government could positively impact the collaboration between industry and academia is by promoting the international adherence to laws regarding the protection of intellectual property.

Concerns have been expressed regarding the possibility that the advantage that the United States now holds in biotechnology might be eroded as a result of the flow of scientific knowledge from the U.S. to other countries.

We believe that this is a real problem. Japan, particularly, has been forthright in its proclamation that biotechnology is a field in which it intends to excel.

That is a formidable challenge, but the answer to the challenge is not, in our opinion, to slow down discovery by stifling the scientific process or the exchange of knowledge on an international level.

Rather, it lies in the prompt recognition of unique accomplishment and the reward of that accomplishment by the granting of patent protection, and the aggressive enforcement of that protection.

Patents are the life-blood of small companies, as well as large corporations. They apply as well to the products of university research. And through licensing they provide a way for the fruits of collaboration between industry and academia to be fairly allocated.

But to be effective, the enforcement of patent protection must cross national boundaries. This is an activity on which we in industry must rely upon the Federal Government to take the lead.

If the United States is to retain its edge in this extremely competitive field—an edge, by the way, which really does exist—U.S. companies must be permitted to apply their technology to the expansion of their markets on a world-wide basis without fear that they will lose that technological property, which is often the very essence of their existence.

The increase in intellectual cooperation between industry and universities is not, in my opinion, an indication that the nature of the research going on in universities is changing.

In the field of biology, much of it consists of very basic investigations in cell biology, immunology and molecular genetics—the kind of basic research which has traditionally been the mainstay of university science programs.

One important characteristic conferred by the tools of biotechnology is the rapidity with which basic science can be transformed into applied science.

Today's discovery at a genetic level can be utilized rapidly, often within months, to coax new products out of cells.

This immediacy of application can create the illusion of decreasing the amount of basic science being done. However, I don't believe that to be the case.

In fact the shortening—excuse me—the shortening of the time line between discovery of basic principles and the application of those principles makes it possible for small companies such as Invitron to support basic science within universities with the likelihood of deriving a return on the investment in a time frame relevant to a start up company.

In the absence of a reasonably short recovery period, it is unlikely that small companies could afford to make such investments; and, the support of university research would be more likely to remain in the province of large, highly capitalized companies.

As to the question of how small companies might take advantage of university expertise, I believe the opportunities are many.

Even though we are a relatively young company, we see a great deal of interest on the part of university researchers in working with us.

Whether it's real or not, the feeling sometimes exists that things happen quicker in a small company and that the impact of an individual, or a single project, may be greater.

We are considering programs which would afford talented university students an opportunity to work on specific problems in their field of interest, either within the university setting, or as a part of a work study program within Invitron.

These might be projects of a basic nature, but they could just as well be investigations into a novel aspect of manufacturing technology.

Given the current emphasis on upgrading the United States' manufacturing base for high technology products, such a program could have both short term and long term benefits.

The presence of a grant system to partially off-set the cost of such a program would be particularly helpful to a small company such as ours.

In summary, I believe that the active encouragement of interaction between American industry and university research centers by the federal and state governments is to the country's advantage.

More ways should be sought to support such programs and even expand them beyond the typical research collaboration. Thank you.

[The prepared statement of Mr. Srigley follows:]

Mr. Chairman, my name is Rick Srigley. I am Executive Vice President and Chief Operating Officer of Invitron Corporation located here in St. Louis. I'd like to convey our appreciation for the opportunity to address the subcommittee on a topic of great interest to companies such as ours and of great importance to the United States.

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Our second area of interest is the development of a number of potentially important products in collaboration with other companies or academic institutions. These include a second generation tissue plasminogen activator for the treatment of coronoary thrombosis, a parathyroid imaging antibody which would help physicians to locate a patient's parathyroid glands prior to surgery, recombinant Factor VIIIc for the treatment of hemophilia, a novel and naturally-occurring antibiotic agent derived from white blood cells, a protease inhibitor having potential uses in the treatment of clotting disorders and cancer, monoclonal antibodies having potential use in the treatment of a number of diseases. These programs are in various stages of development. Two of these projects evolved from collaborations with other companies, the rest came about as a result of collaborative research with scientists at several universities.

Invitron is a research-intense company. In 1987 we spent 34.5% of our total expenses, over 3.4 million dollars, on research and development. We project that number to exceed 5.5 million in 1988. A significant percentage of our research expenses were related to outside collaborations with U.S. academic institutions.

We have been fortunate in that several of our collaborations have qualified for grants under the Small Business Innovative Research (SBIR) program administered by the National Institutes of Health. In our experience this is an example of a Federal program which works well and accomplishes its intended mission. While we are occasionally dismayed by the amount of time and internal resources required to apply for and maintain the grants, and the timing restrictions imposed on the research by the mechanics of the grant process, we are hearty advocates of the program. In the two years that we have been participants, the program has assisted us to support the work of top level scientists at Washington University and the University of Kansas. In the past year we have submitted several additional SBIR applications which, if funded by NIH, will provide financial assistance to support work of scientists at Northwestern University as well as continued work with Washington University.

The cooperation which exists today between researchers in universities and industrial organizations is unprecedented not only in its scope, but also in its spirit. We believe that the SBIR grant program is a clear example of how the federal government can encourage closer ties between industrial and academic researchers and directly benefit both. We intend to continue, and if possible, broaden our participation.

A second way in which the federal government could positively impact the collaboration between industry and academia is by promoting the international adherence to laws regarding the protection of intellectual property. Concerns have been expressed regarding the possibility that the advantage that the United States now holds in Biotechnology might be eroded as a result of the flow of scientific knowledge from the U.S. to other countries. We believe that this is a real problem. Japan particularly has been forthright in its proclamation that Biotechnology is a field in which it intends to excel. That is a formidable challenge, but the answer to the challenge is not in our opinion, to slow down discovery by stifling the scientific process or the exchange of knowledge on an international level.

Rather, it lies in the prompt recognition of unique accomplishment and the reward of that accomplishment by the granting of patent protection and the aggressive enforcement of that protection. Patents are the life-blood of small companies as well as large corporations. They apply as well to the products of university research and, through licensing, they provide a way for the fruits of collaborations between industry and academia to be fairly allocated. But to be effective, the enforcement of patent protection must cross national boundaries. This is an activity on which we in industry must rely upon the federal government to take the lead. If the United States is to retain its edge in this extremely competitive field—an edge by the way which really does exist—U.S. companies must be permitted to apply their technology to the expansion of their markets on a worldwide basis without fear that they will lose that technological property which is often the very essence of their existence.

The increase in intellectual cooperation between industry and universities is not in my opinion an indication that the nature of the research going on in universities is changing. In the field of biology much of it consists of very basic investigations in cell biology, immunology and molecular genetics—the kind of basic research which has traditionally been the mainstay of university science programs. One important characteristic conferred by the tools of biotechnology is the rapidity with which basic science can be transformed into applied science. Today's discoveries at a genetic level can be utilized rapidly, often within months, to coax new products out of cells. This immediacy of application can create the illusion of decreasing the amount of basic science being done, however I don't believe that to be the case. In fact, the shortening of the time line between dicovery of basic principles and the application of those principles makes it possible for small companies such as Invitron to support basic science within Universities with the likelihood of deriving a return on the investment in a time frame relevant to a start up company. In the absence of a reasonably short recovery period it is unlikely that small companies could afford to make such investments and the support of university research would be more likely to remain in the province of large, highly capitalized companies.

As to the question of how small companies might take advantage of university expertise, I believe the opportunities are many. Even though we are a relatively young company, we see a great deal of interest on the part of university researchers in working with us. Whether its real or not, the feeling sometimes exists that things happen quicker in a small company and that the impact of an individual or a single project may be greater. We are considering programs which would afford talented university students an opportunity to work on specific problems in their field of interest either within the university setting or as a part of a work-study program within Invitron. These might be projects of a basic science nature, but they could just as well be investigations into a novel aspect of manufacturing technology. Given the current emphasis on upgrading the United States' manufacturing base for high technology products, such a program could have both short term and long term benefits. The presence of a grant system to partially offset the cost of such a program would be particularly helpful to a small company.

In summary, I believe that active encouragement of interaction between American industry and university research centers by the federal and state governments is to the country's advantage. More ways should be sought to support such programs and even expand them beyond the typical research collaboration.

Mr. **Walgren**. Thank you, Mr. Srigley. Appreciate that testimony.

Turn to Mr. Buechner.

Mr. **Buechner**. Yes, Mike, what are we—we debate quite a bit in our committee on the relationships of limitations on, say, foreign participation in some of these research partnerships.

What do we as a—I guess you can do it as corporate or as country—but what do we have to lose by limiting the access of foreign participation—foreign corporations to take part in these research partnerships?

Dr. **Montague**. Let me see if I can answer your question through an example that comes directly from Monsanto.

Our second largest research partnership is with Oxford University in the United Kingdom. And this has been a very fruitful partnership for us where we are doing research in the carbohydrate moieties that decorate proteins—that are attached to proteins.

And we think that these particular carbohydrate moieties influence the activities of important proteins. And knowledge about that on a fundamental level may lead to drugs that treat various immune system disorders, for example.

If we were in the United States to limit access of foreign companies to universities in America, then it would only be fair for those foreign countries to limit access of a company like Monsanto to their universities.

And we think that that would only result in bad things for both parties concerned.

But the key word here is still fairness. It's critical that there be a mutual reciprocity, an exchange, so that just as we talk about open economic markets, we talk about open knowledge markets, so that we have access to the knowledge base that foreign universities offer, and they have access to ours.

We think that their—that kind of exchange will breed useful products that benefit people throughout the world.

Mr. **Buechner**. One further question for you, Doctor. And that's—on page 3 of your prepared testimony you note that Monsanto spent, roughly, $625 million on R&D.

For the record, could you submit some figures on how much of the $625 million was direct R&D versus what percent represents Federal contracts or subcontracts?

Dr. **Montague**. I don't have those numbers with me, but generally, Monsanto—very, very little if any of our research budget is federally funded.

Mr. **Buechner**. So—then obviously the $15 to $20 million spent on university research by Monsanto would reflect the fact that just a small amount is Federal?

Dr. **Montague**. Indeed. A small amount, if any.

Mr. **Walgren**. Thank you. Mr. Hayes?

Mr. **Hayes**. The point which is so dramatic in the testimony is one that we hear over and over again. And it is one when we attempt to convert that into action we run up with the resistance of slogans and catch-words.

It would be most damaging if we were to take the valid points that you make regarding the free and open access of intellectual markets, just as markets of commerce, and somehow pervert that into the word protectionist.

I am so tired of listening to this kind of testimony from irate people, and then in the political circle get confronted with a word that's 50 years old.

Fifty years ago we did not have this kind of a limited market access. You are sitting here not on a political basis, not on wanting to reduce this to parties' confrontations, but telling us of basic feelings within our own system.

One, with the dissemination of information—not having graduate students even know what the law is, and therefore having no idea if they can violate it.

One talking about Oxford being open to America; America being open to Oxford—but in the next paragraph, Japan being closed to this country; this country being wide open to Japan.

Another one here referring, back in the Bell System, to this same problem, basically, with the inability to sell in some markets.

Whereas, then through a limitation of confusion, total disarray and breaking the Bell System, we end up with a less functional—not more functional.

And what all of them mean is, we do not understand the nature of our competitor. We think of it in terms of America competing with America—and that is not the case.

If America had General Motors, and Citicorp, and Princeton all owned by one big company, that would be an equivalent. And we have got to understand that a technological transfer area in which you are dealing, or in the trade and commerce area, that we are not dealing with the image of us in another place on the globe.

We are dealing with a different system in which case small business is totally out of the picture. And the consequences of which is we end up not with, as in my state alone, 300 banking institutions, but a major company and major entity on the globe where 7 banks are the entire financial institution.

Those are the kinds of comparisons in which this must be framed. And I suggest that the way we approach it is not with a rhetoric, in a political atmosphere, but here in these committees where the Jack Buechners and Jimmy Hayes can work together on confronting trade issues without them erupting into a political debate and political forum.

So you've got to keep coming to arm us with the specifics with which we must act legislatively, instead of getting into the political arena.

However, this afternoon in Iowa I will return to the political arena——[Laughter.]

And then will delight in being able to take some of the things you have said and use them as examples.

I do appreciate your coming and we are indeed very much frustrated.

We need the guidance specifically to be able to react to these marketing conditions. This is an overwhelming burden for this country, but it's one that does not fit 30 second television commercials.

Thank you.

Mr. **Walgren**. Thank you, Mr. Hayes.

Any comments that the panel members would like to make?

Let me ask the—how the patent system works in this, with respect to who holds it. And as I understand it, Dr. Ames, you said the university ought to hold the patent; and I think that is consistent with Monsanto's testimony. And apparently companies go forward in one—individual ways.

But is it a problem of who holds the patent?

Dr. **Montague**. It hasn't been a problem in the sense that we worked out that agreement, for example, with Washington University.

Mr. **Walgren**. Now is that because in pharmaceuticals there may be an agreed upon royalty or a traditional royalty that might not apply in other areas?

How do you work out the licensing compensation?

Dr. **Montague**. That's worked out on an individual basis with each university that we work with, and depending upon the kinds of funding that we do.

I think the key thing here is that universities in the past have not always been as sensitive to patent and protection issues as they might have been.

I think that the whole rise in biotechnology has increased this awareness of the importance of intellectual property—and protecting intellectual property.

Our patent and licensing system is our key method for doing that. So the university must participate in that key method.

Mr. **Walgren**. But why would the comfort level be with the patent lying with the university, rather than the other way around?

Dr. **Ames**. Well, in the case at McDonnell Douglas, when we—when all our research is done at the university with industrial money, what we ask for is a license free use of that patent.

And the university then is permitted to use the patent and to sell that patent elsewhere. Where there is collaborative research, where we are doing part of it and the university is doing part of it, then we both hold the patent; we are both co-signers on the patent. And we share down the middle on that.

What my problem—what our problem is at the corporation is when universities like, for example, the University of Illinois at

Champaign, where the professor, who is in collaboration with industrial money, gets the patent.

That causes problems. It causes morale problems with our researchers who do not like to collaborate with that kind of an environment.

See, the university should own the patent outright, if you see what I am saying.

Mr. **Walgren**. I see. So you are sort of saying, give us a situation where another individual does not hold the patent, but an institution—that seems to enable people to work together——

Dr. **Ames**. And where you share on collaborative efforts, you do part of it, and the university does part of it. That is the way the Federal Government works on contracts—where you have a contract with, say, an Air Force—a laboratory—and they go out and seek the patent. Then you share on that patent.

Mr. **Walgren**. Mr. Srigley, I was interested in your saying that in your situation the SBIR program has been helpful in involving university researchers.

Is that—that must be—particularly because the area that you're in. Because isn't the program itself sort of designed to have the small business doing the research?

Mr. **Srigley**. I suspect that is true. As I mentioned, we are a very research intense organization. Most of the revenues for the first couple of years of our existence came from research work.

And I suspect that we would say it is true, that if it may be a situation where most of our activities evolve around areas that are frequently quite basic in the science, that that's where the grant would come into our activities.

Mr. **Walgren**. How would you weight the interest of companies in going into this kind of thing as an enrichment thing for their employees, either because of the interest that an employee would have in having contact with a university effort—a university environment—or the ability to involve people with your companies that you think in the long run are going to turn out—but particularly graduate students—at that point—would turn out to be good prospects for you.

Can you weigh how much of this effort is out of interest of the company in the product that might come, and how much is the interest of the company in the interpersonal interaction and potential that lies down that road?

Mr. **Srigley**. I would suggest that something in the order of perhaps 40 to 60 percent revolves around the benefits other than products.

And those are often times not real tangible things. The opportunity, for instance, to work closely with research people who are tops in their field is a superb opportunity.

The opportunity to utilize very good researchers as part of the peer review process in the scientific organization—also very useful.

The opportunity to just sit down and bounce ideas up—people who are very good at what they do—is another. Clearly, the possibility that some of those talented people, when they decided that they were ready to leave academia, would see your company as a good place to spend some time is another advantage.

And it is a very powerful one because it provides a way of seating the company with talented individuals—and obviously there is an interest that is very large in terms of——

Mr. **Walgren**. But that can be particularly interesting for the telephone company as is under the present circumstances.

Mr. **Spicer**. Yes, I think he stated it very well. We have a liaison program where we basically have an arrangement with universities where we don't have any product that we get back, or service.

We just understand what their technology is, and we learn about their competence and learn about their graduate students. And then, depending upon that is an intelligence gathering situation, and we find out there is some particular area that we want to deal in. Then we would do it on a particular contract basis.

We think that is an excellent program.

Dr. **Ames**. We at McDonnell Douglas have an active seminar program where we bring in university professors, and both the senior professor—the associate professors—and even assistant professors, or post-docs, to pass information on.

And we then have an information exchange in a particular area to see if there isn't some collaboration that can be begun. And that—we have been doing that for some time.

Mr. **Buechner**. Would the gentleman yield?

Mr. **Walgren**. Yes.

Mr. **Buechner**. Have any of you had a particular university that you were interested in dealing with just tell you flat out they did not want to deal with industry cooperation?

Dr. **Ames**. We have, but not in the past five years.

Mr. **Buechner**. Is that cause you made fighters and bombers? Is that the reason?

Dr. **Ames**. Probably, probably. Although I do not really know the reason.

Mr. **Walgren**. What lies behind your emphasis, Dr. Ames, on doing the research in the private facility and Monsanto's approach which apparently encompasses conducting their research more on university grounds?

Dr. **Ames**. Well, in my statement, what I referred to there is when the facilities are equal and when you have a time restraint, then industry usually wants to do that research in-house, rather than farming it out.

Where there are unique facilities and where there is not a time constraint, then we do not have any objection to that.

Dr. **Montague**. It depends, to some extent, on the type of research that you are undertaking and in terms of the objectives that you are trying to reach.

Monsanto is extremely fortunate in that we have one of the world's highest quality medical schools, Washington University, within ten miles of our main campus.

And that geographical proximity is enormously helpful in establishing such partnerships.

But there are other factors which have to be taken into account. There are simply some kinds of collaborative or partnership fundamental research that are much better done in a university environment with close contact with actual—an actual medical school and a clinic.

Mr. **Walgren**. Very good.

Well, okay. Well, thank you all very much for being a resource to us. We appreciate the points you made. And I look forward to having some contact with you in the future.

Thanks very much.

Mr. **Buechner**. Thank you, gentlemen.

STATEMENT OF DR. PHILIP NEEDLEMAN, HEAD, DEPARTMENT OF PHARMACOLOGY, WASHINGTON UNIVERSITY, ST. LOUIS, MO

Dr. **Needleman**. Thank you.

I think my utility to the panel might be that I am at the level of a university industrial interaction, at the level of a bench scientist—and you could see the perspective of a faculty member involved, and what has turned out to be, we think, a very successful program.

I divide my comments into three parts because much of this started with anxieties about the changing missions once a university might be engaged in an industrial program.

So I have comments about the university perspective and its objectives, of what I believe industry is interested in, and then finally the specifics of our university-industrial interaction with specific examples that might give you insight into how it works.

In terms of a university objectives—a university, in my opinion, has two inseparable missions. That is, teaching and discovery.

A great university—and I have spent my life at Washington University, so to me that is a great university—builds an environment that attracts scholars infected with the joy of learning, with teaching, and discovery.

Thus, a university and its faculty should ideally pass onto its students the pleasures of learning. That really has to be satisfied; and the quest to understand; and, most of all, a willingness to turn over new rocks in discovery.

I, myself, have trained thousands of medical students in the second year curriculum of the Washington U. Medical School. And in my own laboratory I have trained over 50 post-doctoral, pre-doctoral fellows, and people on sabbatical from all countries in the world—from many countries.

What I have learned as the mentor is the best that I can do for a student is open their eyes to the potentials of science.

Students, whether they are pre-doctoral or medical students or post-doctoral fellows, must share their inhibitions; and mentor, as an institution, must reward intellectual risk.

Washington University has the great fortune and the administrative enlightenment to have built and nurtured an environment for scholars and students to flourish.

They have a critical mass of expertise. They have a wide diversity of expertise which allows for advice and collaboration and enrichment of everyone's particular experiments.

By my bias, in many ways—it is the right place, at the right time to do discovery research.

There is, however, one important perspective about the conduct of research, medical research, in the university at this time.

And I think that is worth developing.

While academic institutions provide the intellectual environment, and that is critical, it is the individual scientist who must generate the source of support funds to carry out his investigative activities.

Universities are not in a position to fund research. It is outside support to medical research that carries out these activities.

These derive from competitive applications, especially to the Federal Government and especially, in most cases, to the National Institutes of Health; and, to a much lesser extent, those funds derive from either private foundations or from industries.

The great advantage of the system in this country is that research funds, external of the university and external of a single research czar, have given American scientists the freedom and opportunities to be individually creative; and, that approach is not matched elsewhere in the world.

However, implicitly, that means that the bulk of academic research in this country is an individual laboratory enterprise.

While collaborations between laboratories throughout a university arise and there is a high level of exchange of ideas and methodologies, the rarity is the ability for team research and mobilization of personnel and resource around a single discovery. And that is what might differ from other countries.

Now for more advantage, the industrial approach and objective—and here I focus on my experience about the drug industry and the chemical industry—is that development and commercialization of therapeutic entities should be generated for the alleviation of disease processes.

Enlightened drug companies make a substantial investment in research, but only a small fraction of that is in discovery research. And the largest fraction of that is in development.

The forte of university research is discovery, while I believe the forte of industrial research is development.

While academic institutions nurture this discovery, as I have indicated, they can mobilize to quickly champion a discovery through its development and, in the case of drugs, for the benefit of the patients.

It is only industry that could make the effort in terms of the synthesis of many analogues; or the post-discovery applications to various diseases; or actually even the investments that are necessary to find if new drugs could be safe in animals and ultimately could be safe for use in patients; and, finally, proof of efficacy.

Now, once a drug is identified or once a primary discovery is made, it takes an enormous investment by industry for the development of that drug, which usually means the expenditure of millions of dollars in more research efforts, all performed after an initial discovery.

So we have two separate institutional postures. Now I would focus on the interaction of these two institutions.

In terms of health care, unfortunately, past history was that universities and drug companies were largely uncoupled.

The coinage of success of university research was discovery and not development.

I had emphasized that the liaison—the information transfer from a university to a company, or conservative institutional attitudes, in a fundamental lack of recognition and respect of what could be accomplished by such a joint effort, precluded unique opportunities for advancement.

Rather than delve into generalities, I would now like to focus on some aspects of the Washington U/Monsanto agreement which you have heard something about.

It began in 1982 largely as a reflection of the needs of the institutions at that time. In 1982 Monsanto was interested in expanding into health care as a natural compliment to its chemical activities.

In Washington University, the faculty viewed an agreement as a novel source of funds for a blossoming area of science. While many of the faculty participated in the scoping of the agreement, there were two special people in that regard: one, Howard Schneiderman, who is not here today, and the other is David Kipnis.

Their personalities and individual commitment was really what—this all brought up the institutional barriers and made this a working agreement.

Few of us at that time had the foresight to visualize the enormous advantages that would accrue from the marriage of our technologies while still preserving the traditional missions of both of our institutions.

So it was not just funds for research and possible new patents for an industry that was the result of this.

Briefly, the program is quite simple, and I will encapsulate it in a moment. The funds are basically for research grants for the faculty.

It is reviewed annually by a panel of ten scientists—five from Monsanto, five from Washington University. It is purely done on scientific merit.

If a grant is successful, it is funded for three years, and it is subject to our traditional renewal mechanisms. Our ways in the beginning about—that there was such a difference in the science as expected in the university and industry actually quickly disappear.

The faculty is only interested in funds for discoveries. And Monsanto, largely because they are a unique understanding of what a university should be, patiently allows that science to develop.

Their patience was quickly rewarded; and, since 1982 and the five and a half years since that agreement, there are over 50 awarded or pending patents from the discoveries just from that agreement alone.

These grants are for three years. They are subject to and follow the model of the NIH. So a discovery that leads to a patent is awarded to the investigator; and, what might be unique is the university position that royalties, should they accrue from a patent that arise from this, are signed over to the university.

And in that program a portion of royalties that would be generated would go to the medical school, to the department and to the laboratory; but, not the pocket of the discovery.

So our commitment was for the reinvestment of facilities back into the university and back into the laboratory efforts.

Finally, a world class outside review committee is convened every three years, specifically given the charge: has the university diverted its normal mission; have students or post-docs been inappropriately used in programs; has the industry gotten their money's worth as opposed to putting funds into research and development?

And we believe our program has become a model.

The last points I would like to make are my own personal experiences with the program to give you insight at the level of a bench scientist.

My laboratory observed in about 1983 that rat hearts contained a protein that exhibited a number of unique biological properties, including the ability to lower blood pressure and to control kidney function.

It is immediately apparent that this agent has high therapeutic potential in controlling salt and water metabolism in blood pressure.

In other words, it directly was involved in such disease entities as high blood pressure, heart failure and kidney disease.

This then became the basis of a grant application that I put into the Washington University/Monsanto agreement which was reviewed and funded within three months' time.

Collaborative actions began between my laboratory and the molecular biology program at Monsanto, then in Creve Coeur.

In six months' time we isolated from 14,000 rat hearts enough material—about a microgram and a half—about the equivalent of a grain of salt—enough material to elucidate the structure, to purify it, and then to chemically manufacture it.

So then we stopped dealing with the trivial amounts that could come from an enormous extraction of tissue to large amounts of material that could begin to be used in funivological testing, in toxicity, and ultimately in, hopefully, in clinical trial.

Clearly, neither institution alone could have constituted that undertaking. In the subsequent use, new analogues—that is, mimics of the natural hormone have been prepared.

We have discovered new biologies of this program—of this hormone—and we have studied its role in a variety of human disease states.

Many of these discoveries happen quickly because there was a clear commitment from both institutions that this would work. In fact, eventually there were 48 people both from the medical school and Monsanto engaged in these projects.

Now subsequent to that time, Monsanto purchased Searle as the developmental arm. And many of us believed it accelerated their plans for development because initially they were in a discovery arm and, I believe, expected only to go to the 1990s before they would be ready for clinical applications.

Their acquisition then meant that the Searle company of Monsanto then undertook the toxicology which was then successful, while the Monsanto molecular biologists succeeded in a synthesis of large amounts.

Now kilogram quantities, which are necessary for clinical trials, and havile—something that was ground up—homogenates in a Waring blender in 1983 is now in worldwide clinical trials.

Now that problem was a genuine horse race at the time. It was underway in Japan; it was underway in Scandinavian countries; it was actively underway in Canada.

The rapidity with which we could mobilize led to the award to Washington University, through our efforts, of the first patents—the first American patents for both the hormone and its precursors, which now serve as a basis of a wide international activity by many drug companies.

Clearly, this interaction between Washington University removed the lag period between discovery and development. Clearly, it allows the discoverer to become a champion of its development all the way through to the possibility of a clinical trial.

So in conclusion I might ask, what has been achieved by the Washington University—now, Searle—agreement?

Our program is in its earliest phases. While there may be many substantive trials which lay ahead for us and many complications, a fair foundation of cooperation and scientific excellence has been established.

Perhaps our particular circumstance has certain unique advantages. Clearly, it is to unique institutions that have a tradition to excellence.

Second, there are high quality resources and scientists in both places. You see, I am not interested in collaborating with second class scientists. I am not interested in scientists who are not going to push us to think of better ideas and better discoveries.

So if there isn't a marriage that involves high quality interactions on both sides, you have a mismatch. I agree with the earlier statement that juxtaposition was critical.

To shoot down highway 40 in 10 or 15 minutes to test an idea or a new discovery—for example, when we first came, you know—you isolate something as an extract from heart; and you get a nine cents set of amino acids; and you do not know what it means.

You kind of believe in it. But finally, when it was synthesized in Creve Coeur, and they raced down highway 40, and we tested it in our biological system, and the chemically produced material exactly matches the native hormone, then you have got it.

And we could not wait—while he was coming down highway 40, we were chilling the champaign bottle at work. [Laughter.]

Dr. **Needleman**. A most important issue, finally, is that fit of personalities. That is, that commitment, maybe best exemplified by Howard Schneiderman and David Kipnis, and the tradition of the universities, that you can trust people and allow for the possibility that a scientist can make a discovery that could be commercially important.

Scientists are happy to see an agent or something that they discover applied across society. They love the discovery, but the ultimate application is important to the university as it is to the industry.

I believe that the societal advantages of such a crafted alliance, when it works, fulfills the highest expectation of both universities and industry.

Thank you.

[The prepared statement of Dr. Needleman follows:]

Prepared Statement of Philip Needleman, Ph.D., Professor and Head, Department of Pharmacology, Washington University School of Medicine

UNIVERSITY OBJECTIVES

In my opinion a university has the two inseparable missions of teaching and discovery. A great university, like Washington University, builds an environment that attracts scholars infected with the joy of learning, teaching and discovery. The teaching objectives focus on the transmission of a knowledge base, the development of decision making capabilities, and the creation of skepticism and curiosity amongst its students. A university and its faculty should ideally pass on to its students the pleasures of learning, an unwillingness to be satisfied, a quest to understand, and most of all, a willingness to "turn over rocks."

I have trained thousands of medical students and more than fifty scientists in my laboratory. What I have learned is that the mentor does not create good or average scientists. Instead, the mentor at best opens the eys of the students to their potential. The students shed inhibitions and mentors and institutions must reward intellectual risk. Indeed, the faculty must remain students. A university must provide a setting for the continuing education of its scholars. In essence, we are the business of worshipping ideas. Ideas arise from scientific journals, from seminars, from meetings (national and international), from experimental data from colleagues, and from collaborative interactions. Washington University has the good fortune to have built an environment for scholars to flourish. There is often a critical mass of expertise of wide diversity, for advice and collaboration. Importantly, there is an administrative enlightment that nurtures the precious jewel of science. In many ways this is the right place at the right time for discovery research.

One additional perspective about the conduct of medical research in a university is worth development. Academic institutions provide the intellectual environment, the physical plant, some salary, and clerical support and an overall commitment to scholarship. However, it is the investigators that must generate individual research funds to support his research activities. Universities are in no position to accomplish this task. Outside support to medical research is derived from governmental funds largely from the National Institutes of Health and to a lesser extent from non-government sources including private research foundations and industry. A scientist submits proposals that are evaluated based on the rationale and uniqueness of the hypothesis, the clarity of the strategies, the adequacy of the methods, the demostrated feasibility and skills of the laboratory. The great advantage of this system is that these external funds have given American scientist freedom and opportunities for individual creative accomplishment—not matched elsewhere in the world. On the other hand, the net result is that the bulk of academic biomedical research is, by and large, an individual laboratory enterprise. While collaboration between individual larboratories arise and a high level of information, methodology, and exchange of ideas frequently occur in a university—team research and mobilization of personnel and resources around a particular problem are a rarity.

INDUSTRY OBJECTIVES

From my vantage point, the object of drug and chemical industry, with which I have some familiarity, is the development and commercialization of therapeutic entities for the alleviation of disease. Enlightened drug and chemical industry makes a substantial investment in research. While a portion of the investigative effort is in discovery research, the majority of its resources are often focused on development.

From my perspective, the forte of universities is discovery and the overwhelming strength of industry is development. Indeed, industry can uniquely mobilize funds and resources for modern instrumentation and facilities or can accomplish focused efforts not achievable in universities. As indicated above, academic scientists cannot readily mobilize personnel and resources around a discovery, even of great therapeutic potential. While a discovery is a unique event—the subsequent development of a candidate agent into a drug is a monumental undertaking that can uniquely be accomplished in industry. It is only industry that could devote the chemically trained personnel for the sythesis of a discovered substance in an effort to develop drugs that are effective, potent, long-lasting, and adequately free of side effects. More recently, especially in companies like Monsanto, the application of biotechology (e.g., recombinant DNA technology, monoclonal antibodies, large scale tissue culture methodology, etc.) has provided unique approaches for drug discovery and development that are unmatched in any single university program. Once candidate drugs are identified, chemists in industry must develop and implement strategies for bulk product synthesis; biologists must engage in toxicity studies and investigations of other actions of potential drugs; and clinicians must undertake, when appropriate, the human trials to establish safety and efficacy. Overall, the industrial commitment for the development of a drug involves years of effort and millions of dollars—all performed after the initial discovery.

UNIVERSITY-INDUSTRIAL INTERACTIONS

I have described the characteristics of two distinct institutions interested in health care. Unfortunately, in this country these enterprises have often been uncoupled. The coinage of success in University research has been discovery and not development. The delays in information transfer, conservative institutional attitudes, and a fundamental lack of recognition and respect for what could be accomplished by joint efforts have in my opinion precluded unique opportunities for advancement.

Rather than delve into generalities, I would now like to specifically focus on the unique alliance we have forged betweed Washington University and Monsanto. The initial motives for the agreement in 1982 derived from the needs of the institutions at that time, as I perceived them. Monsanto was turning its attention to health care as a natural compliment to its chemical expertise and the prospect that university discovery groups might provide entry into unique research areas. Some of Washington University Medical School viewed the agreement as a novel source of research funds in a blossoming area of science. While many of us participated in sculpting the details of the agreement, Howard A. Schneiderman, Ph.D., Senior Vice President, Research and Development of Monsanto, and David Kipnis, M.D., Head of the Department of Medicine at Washington University were the critical solvents and glue that achieved the dissolution of institutional barriers and the cementing of interactions. Few of us had the foresight to visualize the enormous advantages that would accrue from the marriage of our technologies while still preserving the traditional mission of both our institutions.

Briefly, the program focuses on the role of proteins and peptides in human disease. A review group of 10 scientists, 5 from the medical school and 5 from Monsanto-Searle, annually reviews faculty submitted research proposals. There are two types of proposals: (1) an exploratory grant equivalent to an NIH-R01 individual grant, and (2) an applied grant involving a grouping of investigators equivalent to an NIH program project. Grants are reviewed based on scientific merit only and when successful are funded for 3 years. The conduct of science by the awarded investigators follows exactly the same procedures as any NIH grant with the one exception that publications derived from this support must be submitted to the Monsanto-Searle lawyers for patent decisions. An outside group of world class scientists externally reviews the program every 3 years addressing issues of the quality of science, possible diversion of institutional mission, administrative practices, etc.

However, the delay period is maximally 30 days from the submission of a draft of a manuscript. In this regard, my own experience based on our discovery of a new hormone produced in the heart—an agent with considerable therapeutic potential—that only nine days elapsed from submission of our manuscript and patent filing. Currently, I believe in excess of 20 patents have been filed or awarded from the Washington University-Monsanto/Searle agreement. Monsanto has the first rights for development of discoveries. The patent strategy follows the NIH guidelines with the unique exception that should royalties be awarded, they will be funneled back to the institution, the department, and the laboratory of the discover. The investigator does not accure a personal profit, but rather funds if generated will be reinvested into the research efforts.

Now briefly, my personal experience with this program. My laboratory observed that rat hearts contained a protein that exhibited a number of biological activities, including being a blood vessel relaxant and a potent stimulator of kidney function. It was immediately clear that such a substance and therapeutic potential in the manipulation of blood pressure and water and salt metabolism and was relevant to such pathological situations as kidney disease, high blood pressure, and heart failure. This discovery served as the basis of a successful grant application to the program. Collaborative interactions between our laboratory at the Medical School and the Molecular Biology unit at Monsanto resulted in the purification, structure, analysis, and chemical synthesis of this novel material in less than six months. Clearly, neither institution alone could have accomplished this undertaking. In the subsequent years, new analogs have been prepared, new biological actions have been identified, and the role of this hormone system in various human disease states have been studied.

Many of these discoveries were collaborative resulting from regular weekly meetings, the rapid exchange of data and ideas, the mobilization of resources, and the commitments of two institutions to make things happen. During the interim, Monsanto acquired Searle where development efforts on the cardiac peptide continued with toxicology testing and preclinical pharmacology. Monsanto chemists and molecular biologists perfected the bulk synthesis of the peptide either with recombinant DNA technology or conventional peptide synthetic techniques. Finally, and most gratifyingly, human clinical trials are underway to assess safety and efficacy. The cardiac peptide may evolve into an important therapeutic agent or it may not. This will be a matter of clinical testing. Perhaps the native substance which we identified may not be the ideal agent. But other generations of experiments could lead to new agents that mimic or release or block the endogenous material for therapeutic advantages. This entire effort occurred in less than five years. The agreement removed the lag period between discovery and development.

What has been achieved by the Washington University-Monsanto/Searle Agreeement? Our program is in its early phases, and while many substantive trials lie ahead of us—firm foundation has been created. Perhaps our particular circumstances have unique advantages including institutional commitment and tradition; high quality resources and scientists; juxtadposition; and perhaps most important, a "fit" of personalities and respect. The societal advantage of such a crafted alliance, when it works, fulfills the highest expectations of universities and industry.

Mr. Walgren. Thank you very much, Dr. Needleman. We appreciate hearing that story and those events. We want to express our admiration for the ideals that lie behind it as well.

Dr. Danforth.

STATEMENT OF DR. WILLIAM H. DANFORTH, CHANCELLOR, WASHINGTON UNIVERSITY, ST. LOUIS, MO

Dr. Danforth. Mr. Chairman, thank you very much.

I want to express appreciation to the panel members for coming to St. Louis and for holding this hearing. I have been here since the start of this morning.

I have been very impressed with the testimony, and I might add that I am very impressed with the quality of the questions and the interest of the three panel members that are here.

If we had all people in the United States with the kind of understanding and interest that you have, even in Washington, D.C., we would be in great shape, I would say.

Mr. Buechner. Bill, let me interject—Mr. Chairman, if I would.

I think the record should indicate that Chancellor Danforth has a somewhat familial relationship with a certain senator Jack Danforth, who is the ranking member of the committee that would have the compared jurisdiction to science, space and technology.

Just in case someone did not know that I thought we ought to emphasize it. [Laughter.]

Dr. Danforth. Thank you.

Mr. Walgren. Well, he was shown, but the political instincts of the Danforth family——[Laughter.]

Dr. Danforth. My remarks—I will try not to duplicate what has been said. And I will not duplicate my written testimony that has been handed in.

First, I would like to make a general statement. I think we are dealing with a matter vitally important to America's future—both economic future and its future as an international leader.

Second, I believe, in this regard, I believe that we have the brains, the tradition, the human power to be successful and to be second to no nation in the world.

I believe, though, that to realize our potential as a nation requires cooperation and the kind that we are not used to. And that might be highlighted in the remarks made by Congressman Hayes.

We have to work together. We can no longer afford not to—and by we, of course, I mean the Federal and the State governments, as well as universities and business.

One specific matter, I do think that the arrangement between Monsanto and Washington University has led the way to building a productive and workable partnership between a great American business and a major university.

You have heard about this arrangement and its successes, and I just concur with what has been said.

It is fun to follow Professor Phil Needleman and hear his description of it if you want to know the key role of the central administration in working out how science goes in the university and arrangements like this—how important the chancellor is.

Reminds me of the coach of the Kansas City Royals who was asked how he coached George Brett, and the answer was, "I say, 'atta way to hit George'." [Laughter.]

Now I would like to talk about some of the importance of the Federal Government, just briefly, for both universities and businesses, that are absolutely dependent on the Federal Government for their successes and cooperative endeavors, and, indeed, for their very existence.

The success of major research universities—all research universities in which the vast majority of basic research takes place in the United States—depends upon enlightened policies of the Federal Government.

Since we have enlightened leaders here—and I would like—we have enlightened leaders here, you all know the problems and the opportunities, as well as I.

But I would like to touch on them just to emphasize that I think they're important.

First, Federal funding of research needs to be adequate and stable. There can be no illusion that industrial or state support can substitute for the Federal support.

Research—that is, basic research, as opposed to the developmental strength of the U.S. and, in fact, every other government in the country—in the world, that I know of—depends upon far-sighted support of the central government.

To maintain our lead will require an increase in the Federal spending on non-defense R&D.

Second, the Federal Government, as the senior partner in the governmental/university partnership, must take care not to weaken the infrastructure of the junior partner. In other words, not to kill the goose that lays the golden egg by trying to buy research on the cheap, as, for example, trying to buy—pay less than full cost for the research.

Financially weakening the universities will help no one. Facilities are a problem. Facilities in which to do research need to be supplied. They need to be built; they need to be maintained.

A Federal matching program for research facilities is needed. The restrictions on independent universities to use tax exempt financing for such facilities should be removed. This was put on in the last tax reform act.

The basic problem here is that universities have become capital intensive. That has been increasing over a number of years. It has been clouded by the fact that the Federal Government supplied so much capital in the 1960s.

That problem is coming home to roost.

I calculate—and one other thing, universities are capital intensive but they do not generate capital. That capital has to come from the outside.

I calculated Washington University, if we are going to maintain ourselves and do well in the future, we need a minimum of 25 to 30 million dollars of new capital a year. And that is very, very hard to come by.

Three, keep the research—we need to keep our research system competitive. America has done well because funding has historically gone to the best projects and not to the institutions with the most political clout.

Now that is a bit of an overstatement, but generally the merit system has worked very well. And it works—I think that's what that competitive system has created: such an excellent research system in the U.S.

Fourth, the U.S. should provide adequate incentives in support for industrial R&D and remove disincentives for domestic R&D.

To help in these regards, we have a new report: "The National Research and Development Policies for '88 and Beyond: The CORETECH Agenda." CORETECH is Counsel on Research and Technology, which has—is made up of some 45 companies and 80 universities plus a number of other organizations.

And if possible—one might like this, and it might go into the record. I have extra copies if anyone would want them.

Mr. **Walgren**. I will take that and look at it for purposes of including it in the record.

Dr. **Danforth**. Okay.

[See appendix, p. 177.]

Dr. **Danforth**. Among the recommendations are: to strengthen the R&D tax credit to its original 25 percent incremental rate and make it a permanent part of the U.S. tax code, so that that can be counted on; and make permanent the basic research credit which encourages companies to support basic research within universities and other qualified institutions.

Fifth, finally, we all need to pay attention to the future supply of American scientists. We have the best research training in the world, no doubt about it.

People come from all over the world to our institutions to get training. Many of them will go back home and take what skills they have learned back to other lands.

We must provide the financial resources to encourage young Americans to make use of this training that we have. Other countries are doing so; and, if we are going to remain in the forefront, we just have to keep that supply coming along.

Well, I could go on and on but I do—in summary, I believe that if we plan well, if we use our resources well, if we work together efficiently, we would have unlimited potential.

But it will not just happen. It is going to require a lot of leadership. And I thank you for this opportunity.

[The prepared statement of Dr. Danforth follows:]

U. S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

Field Hearing on University-Industry Alliances
St. Louis, Missouri
February 8, 1988

Written Testimony of William H. Danforth
Chancellor
Washington University

University-Industry Relations

Research and technology transfer relations between universities and industry are of significant mutual benefit to the parties and provide opportunities for increased contribution to national competitiveness and regional economic development.

Such relationships are stimulating to both university and company scientists and engineers and provide to them expanded opportunities to explore and develop new concepts in science and technology. These cooperative activities are rooted in and built on the main program of fundamental academic research which continues to be supported primarily by agencies of the federal government. By complimenting government-supported research, our relations with industry make increased use of creative university research resources, thereby enhancing the productivity of the long-standing government-university research partnership in the public interest.

e strength and value to the nation of this government-university-industry alliance depends on several key factors. Stable direct financial support for fundamental research that continuously adds to the scientific knowledge base is obviously essential to provide a springboard for scientific breakthroughs and advances in technology. Of increasing concern in the academic community is the ability to maintain state-of-the-art research facilities and instrumentation, the infrastructure upon which research at the cutting edge of science and technology depends. Improved means and incentives for all elements of the industrial community to participate in the alliance, whether large, medium or small companies, will contribute to national and regional economic development. Finally, academic institutions must continue to design and control their relationships with industry in such a manner that their commitment to academic freedom and the pursuit of fundamental knowledge remains unimpaired.

Encouragement of Business

University research relations tend to be conducted mainly with major corporations which possess the financial resources and the in-house R&D capabilities to support university research and to convert fairly undeveloped discoveries made in academic laboratories into commercially viable processes and products. Many smaller companies find serious barriers to their participation in university research for they do not possess the finances nor their own R&D capabilities to develop and commercialize university discoveries. Government agencies offer Small Business Innovative Research (SBIR) programs, but such programs are structured in a manner which does not encourage companies to seek research relationships with universities. Under SBIR programs, a company must divert its limited rsonnel and resources to research, it must depend primarily on its own ideas for novative research, and it must be able to span a 6-month gap in funding after commencing research and development. Greater flexibility in structuring SBIR research projects would encourage more companies to work with universities on innovative processes and products, an initiative which would enhance regional economic development.

Encouragement of Business (continued)

A potential problem area, which must be anticipated if universities and smaller companies are to be encouraged to work together, is the threat of product liability. In technology based relations with large companies, universities feel relatively confident that indemnification by a major corporation provides effective protection of a university against the risk, however small and speculative, of catastrophic financial loss from legal action based on marketplace events. There is evidence that smaller companies do not have the assets to provide indemnification nor the revenues to purchase major insurance protection for the university. Should research collaboration with industry lead in the near future to involvement of universities in major law suits based on occurrences in the commercial marketplace, academic institutions would be compelled to reevaluate the advisability of continuing involvement with commercial firms.

Relations with Government

In recent years, the federal government has taken positive action to encourage and support the development of university-industry research and technology transfer relationships. Continued support is essential for national and regional economic development. However, there are indications that the essential role of government is being eroded, i.e., changing from an investment to a procurement concept. For example, recent statements from some legislators indicate a desire to remove the tax-free status from applied research conducted at universities which would then be classified as "unrelated business income." Such a move would constitute a disincentive for university-industry cooperation in research.

Another area in which there appears to be a lessening of understanding concerns the major problems faced by universities in maintaining the infrastructure essential to the performance of state-of-the-art research. The rate of obsolescence of facilities and instrumentation constantly increases, demanding earlier modernization or replacement. However, the provision of effective means to finance such needs is not well recognized and supported. Limitations on tax exempt financing of facilities have been imposed and reduction of current 30- and 20-year cost recovery periods for research facilities and equipment, respectively, lacks support.

The enactment of PL96-517 and PL98-620, which leave patent rights with universities, plus agency programs to provide initial seed funding for university-industry collaborations are illustrative of the affirmative action government has taken to encourage university-industry relationships. Continuous attention to the maintenance of the vitality of the academic research enterprise by such action is essential in the public interest.

State Programs

The State of Missouri, like some other states, has implemented programs to stimulate cooperation between industry and universities. Such programs focus on opportunities at the state, regional and local level which cannot as effectively be directed from the federal level. These state programs should be encouraged as an essential component of national economic development initiatives.

Foreign Relationships

Concern has been expressed over the involvement of foreign entities in the research programs of American Universities. Care should be taken to separate the normal international character of science from the attempts to acquire legal rights to U.S. technology by foreign companies. The free communication and collaboration of scientists the world over is an essential characteristic in the expansion of mankind's store of scientific knowledge. No restriction on interactions among these scientists would be productive.

Mr. **Walgren**. Thank you very much, Dr. Danforth. And then Dr. Baue.

STATEMENT OF DR. ARTHUR E. BAUE, VICE PRESIDENT, MEDICAL CENTER, ST. LOUIS UNIVERSITY, ST. LOUIS, MO

Dr. **Baue**. Thank you very much, Mr. Chairman. I also appreciate your coming with your committee members and fellow Congressmen to St. Louis to allow us this opportunity to comment upon your tasks in the Congress.

I will shorten my remarks that I have submitted to you in order to save time. And also many of them have been stated earlier by others.

I am Vice President for the Medical Center of St. Louis University. St. Louis University is a private urban Jesuit institution and is the oldest university west of the Mississippi River.

Its roots in the health sciences date back to 1836 when the school of medicine was first established. It is interesting that that school of medicine then became the Washington University School of Medicine.

St. Louis University then started another one. This shows a close cooperation of our two private universities here in St. Louis.

At St. Louis University, the great majority of the Institution's totally funded research is done within the school of medicine.

As with most medical schools, the largest funding source is the NIH. Although our research volume places us within the mid-range of American medical schools, the rate of increase in the past several years has significantly exceeded the national average which we feel reflects on the growing strength and quality of our faculty.

Similar to most medical schools, we have participated in the growing ties between universities and private industry. A number of our faculty have been involved in working arrangements with biomedically related industry; and, these arrangements are principally—included supported research, supplying of laboratory materials, utilization of sophisticated equipment, and individual consultation.

These arrangements have usually worked in both directions since our counterparts in industry also have much to offer the faculty investigator, thus furthering the basic academic principle of open exchange of scientific information.

Another avenue of affiliation with the industrial sector is our participation in the planning and development with the other schools in the region—the St. Louis Technology Center. You will be hearing more about this a little later on.

This center, which also enjoys the support of other local universities represented here today, is an incubator for emerging technology based businesses.

In addition to our general support for the center, we also have direct involvement with the work of some of the clients.

We have also invested in a program to develop a research institute with all the schools in this region in association with the St. Louis Regional Commerce and Growth Association. And I think you will be hearing more about that in later testimony.

Our medical center stands toward industry-university alliances. It has won a general and strong encouragement of faculty, and the programs, as the possibility of relationships arise.

We plan a more active role in promoting this possibility of the faculty now and in the future. Although there are pros and cons in these arrangements—and this is reflected in our positive and careful approach—I think the day is gone when there is academic concern about these relationships. And I think some of the far-reaching programs, such as those developed by Washington University, speak well toward a better understanding of how the academic community can benefit from that.

We have developed principals and guidelines for the St. Louis University Medical Center, which I think are pertinent to this discussion.

And these include a number of areas: number one, faculty priorities, which are important to maintain in a teaching and research university; second, publications; third, the matter of patents, trademarks and copywrites—a number of things have been said about that; fourth, cost reimbursement; fifth, shared use of equipment and facilities; sixth, liabilities and risks; seventh, private consulting for disclosure and, particularly, potential conflicts of interest of faculty; and finally, the negotiating process, which most investigators need central administrative help with.

Finally, I would like to say that I think it is particularly important and appropriate that these hearings are held shortly following the indication from the Office of Management and Budget that consideration might be given to privatizing the National Institutes of Health.

Chancellor Danforth has spoken to the increased need for supported research. I believe the issue is raised regarding university-industry alliances are the same ones which argue most strongly against the wisdom of privatization.

The extraordinary progress made in biomedical research over the past decades to the competitive peer review system of the NIH has been an outstanding credit to the United States.

It is, I think, the major factor that has put us in leadership role in biomedical research in the development of health care.

It is critical to the continuation of this success story that the attributes of independent peer review and public funding for research, and also research training, be maintained and that the NIH be allowed to continue to flourish.

Cooperative undertakings between industry and universities are important but cannot take the place of the NIH and its intra- and extra-mural programs.

I think then the relationships of industry and university for research are important, and they compliment what is presently being done through public funding.

Thank you, then, for the opportunity to provide these few thoughts to your examination. And I wish you the best in the proceedings.

[The prepared statement of Dr. Baue follows:]

CONGRESSIONAL HEARING - FEBRUARY 8, 1988

I am Arthur E. Baue, M.D., Vice President for the Medical Center of St. Louis University. St. Louis University is a private, urban, Jesuit institution, and is the oldest University west of the Mississippi River. Its roots in the health sciences date back to 1836, when the School of Medicine was first established.

At St. Louis University, the great majority of the institution's total funded research is done within the School of Medicine. As with most medical schools, the largest funding source is the National Institutes of Health. Although our research volume places us within the mid-range of American medical schools, the rate of increase in the past several years has significantly exceeded the national average, which we feel reflects on the growing strength and quality of our faculty.

Similar to most medical schools, we have participated in the growing ties between universities and private industry. A number of our faculty have been involved in working arrangements with biomedically related industry. These arrangements have principally included supported research, supplying of laboratory material, utilization of sophisticated equipment and individual consultation. These arrangements have usually worked in both directions, since our counterparts in industry also have much to offer the faculty investigator, thus furthering the basic academic principle of open exchange of scientific information.

Another avenue of affiliation with the industrial sector is our participation in the planning and development of the St. Louis Technology Center. This Center, which also enjoys the support of other local universities represented here today, is an "incubator" for emerging technology based businesses. In addition to our general support for the Center, we also have direct involvements with the work of some of the clients.

We have also invested in a program to develop a Research Institute with all schools in this region in association with the St. Louis Regional Commerce and Growth Association.

The Medical Center's stance toward university-industry alliances is one of general encouragement to faculty as the possibility of individual relationships arise. We plan a more active role in promoting this possibility to the faculty, now and in the future. We see both pros and cons in these arrangements, and this is reflected in our positive, yet cautious, approach.

On the positive side, it is stimulating to our faculty to broaden their contacts, particularly with scientists who are working in applied research settings. The exchange of information resulting undoubtedly furthers progress on both sides. Second, it offers opportunities for the growing number of academics with entrepreneurial drive to find potential outlets for these ambitions.

Third, if there are patentable concepts that result from the association, royalty income may accrue through licensing, which normally results in financial reward to both the faculty member and the institution. As a general policy, any such revenues received by the University would be used to enhance the general research program.

Despite the advantages to the University briefly enumerated here, there are also some issues which cause us to move deliberately. At root, any university is committed to protecting an environment of free inquiry and open dissemination of ideas. University based research is concerned primarily with the advancement of fundamental knowledge. It is traditional and appropriate that this knowledge be disseminated widely, primarily through publication, so that other scientists may build on it and advance it for the good of society. Industry, on the other hand, is directed primarily toward applied research, and the development of products for the marketplace. These goals are not incompatible, and the successful transfer of technology through stages leading to the marketplace is crucial to the future of our economy.

However, the attempt to intertwine the work of these two entities, the University and the corporation, is a sensitive task. The University must be reassured that its mission is not distorted, and that the effort of its faculty remains focused on the educational and basic research enterprise which forms the reason for its being. Pressures on faculty are already intense and workloads are heavy. Alliances with industry can be handled within this context, but not without careful selection and monitoring.

It is appropriate that these hearings are being held shortly following the indication from the Office of Management and Budget that consideration is being given to "privatizing" the National Institutes of Health. I believe the issues raised regarding university-industry alliances are the same ones which argue most strongly against the wisdom of privatization. The extraordinary progress made in biomedical research over the past decades through the competitive peer-review system of the NIH has been an out-standing credit to our country. It is critical to the continuation of this success story that the attributes of independent peer review and public funding be maintained and that NIH be allowed to continue to flourish. Cooperative undertakings between industry and universities are important but cannot take the place of the NIH and its intra- and extra-mural programs.

I thank you for the opportunity to contribute these few thoughts to your examination of cooperative undertakings between universities and industry.

Mr. Walgren. Thank you very much for that testimony.

Mr. Buechner.

Mr. Buechner. Yes, I would like to ask Chancellor Danforth or Dr. Needleman, either one, but has the involvement with industry opened up for the university any additional sources of private funding for your facilities—I mean instrumentation—any things that obviously required capital that you spoke of, Bill?

Dr. Danforth. Yes, the Monsanto grant has provided some money for capital—for equipment. But generally other industry arrangements do not do so.

So it is a relatively small amount in the total need of the university.

Mr. Buechner. Doctor, does—go ahead and finish answering that. But are there any other companies that you have relationships with—the medical school has relationships other than Monsanto? And if so, who are some of them? And, you know, is Monsanto's arrangement atypical, or is it typical?

Dr. Needleman. The first issue about equipment and capitalization—I want to make clear that it is not the tail that waives the dog; that the Monsanto grant represents only 6 percent of the funds—research funds at any given year of the Medical School, with the bulk being NIH.

And large instrumentation usually comes from NIH applications.

By the way, I do not think the university/industrial interactions would be nearly as successful at all if it was not for the independence that comes to investigators because of the NIH.

If I have a message for Congressional Committee it is: there is nothing quite like an individual investigator who has funds independent of his institution and could follow creatively without pressures other than the quality of the sciences.

Have like—how proud the plains Indian was when he had a horse. So no one can tamper with that drive for science.

And I think that made it possible when facing industry. So there were early differences of opinion. While top scientists agree, lawyers would have liked to have—I will give you a little example.

We discovered this arterial peptide out of the heart; and the sooner we synthesized there—had outside collaborators from other universities.

And it was very early. And the lawyer jumped in before some of the scientists like Howard Schneiderman. And I said, "I'd like to send some of this material." We have a simple form that they could sign off on that they do not do human trials with it, because it was not proven for efficacy.

And they said, "What do you mean you want to send it to a collaborator?"

And then I had a call from a lawyer who said, "How important is it for you to control who it goes to? We want to decide." I said, "How important is it? This is Tuesday. I would have an NIH grant application in the mail by Saturday; and you could buzz off with your funds."

And so later when we turn to the level of scientists, I should emphasize that that independence comes when you're not beholding for those funds in the duration.

Now capital equipment by and large could come as part of an individual grant, is one mechanism, and some of that came from Monsanto.

The second thing in that Washington U./Monsanto funds, while we always agree, both the five and five from university or from industry, what the best grants are, we stopped agreeing fairly low down.

So there might be a project that Monsanto or Searle might be interested in because it is directly applicable to a clinical trial or some clinical aspect which we don't think is high quality science.

So we cut off much earlier. And instead of in any given year committing all of the funds, what we agreed to do is occasionally, if there is a balance, put it into central equipment that would be usable for everyone.

I address it all—so if their six percent of the total funds—I suspect as little as maybe ten or 20 percent of their funds goes into capitalization of equipment. The vast majority is the competition for federal funds.

As to other interactions, they are fairly small. There are individual contracts that might come for testing a specific drug, for example, in a clinic.

So they might have some new therapy for a myocardial infarction. I know there are programs for anti-convulsions. But they are largely clinical trials with the company usually testing efficacy.

Nothing of the magnitude of the Washington U./Monsanto grant.

Mr. BUECHNER. Thank you, Phil.

Mr. WALGREN. Thank you, Mr. Buechner.

Mr. Hayes?

Mr. HAYES. Yes, I was interested in Dr. Danforth's comment. And I am really going to ask only one question because of time constraints.

All of us recognize that were it not for the fact that immigration into this country brought so many talents from so many parts of the world—especially in scientific achievement.

We could not begin to list those people who resided elsewhere and were inspired, for one reason or another to move here. It was the German side—equated energy and mass times the velocity of light square—we might have a German flag outside of the Courthouse instead of an American one.

But you touched upon, at the same time, the lack of our inspiration for our own children coming into the sciences. And Chairman Bill Nelson of the Space Subcommittee has done enormous work with the young astronaut program which was not intended to train all of our young people to be astronauts but to introduce them to the basic sciences.

And I wondered what your comments might be on if you were to prioritize for me those things which you think would be most effective that government could do to provide the briefing that we had mentioned by a specific program in Missouri this morning.

What is the best that we can do to introduce some of our young people into both an acquaintance and a desire to participate in the sciences?

Dr. **Danforth**. Let me say, that is a very complex problem for the United States. There is a study going on looking at that general problem now.

It is being—it is under the auspices of the National Academy of Sciences. And I do not know an enormous amount about it.

Don Phillips may know more. He is still here.

But clearly we need to explain—do a better job explaining science to young people in K through 12 education. We need to create an enthusiasm for what might be done and a commitment to going into a scientific—getting a scientific education, getting a scientific career.

We have to improve the quality of science teaching in the K through 12 areas; and that means not only training people, it means some way of paying salaries so that they don't all go to work for computer companies—some of them stay as teachers.

I am, of course, most familiar at the level of higher education. And here the problems include the fact that many of our students are running up debt. And they are reluctant to take on further debt to go on beyond the Bachelor's degree to get a Ph.D., and then go into possibly a relatively low paying profession.

The—we viewed better financial support for those young people who are going on to a graduate education. And there are various proposals before the Congress, including Representative Tom Coleman from Missouri, who is very interested in this problem, for building more support for graduate students.

I consider that very important, and I also consider the general strength of the support of basic research very important.

If one gets a young person coming up with a degree in computer science, or chemical engineering, or what have you, the jobs in industry are much more lucrative than the jobs in universities. Not only that, but the equipment may be more modern in industry. The opportunities are greater.

So I think building the research—keeping up the research capability of universities will help not only in the basic science but in the making of the jobs more attractive to keep young people flowing into those jobs.

Mr. **Hayes**. Thank you.

Thank you, Mr. Chairman.

Mr. **Walgren**. The—Dr. Needleman, you emphasize that it is the individual investigator that has to generate the money to support a line of research and that the university is not in any position to do that.

It raises in my mind—asking, what's in this for the university? Why is the university interested in pursuing these things?

Now one reason would be perhaps as a line of support—there for an individual investigator or an individual project. But other than that, you get into putting your faculty members out where they might get tempted away, where the salary structure of the university is probably pushed by the comparison with the private sector. The total that we can expect from this area is really not so large to really be a substantial influx to the university. I would like—wonder your comments. Just what do you see as the greatest advantages to the university?

Dr. **Danforth**. I can tell you what I see.

Mr. **Walgren**. Yes.

Dr. **Danforth**. I think it is the opportunity to be a part of one of the great and exciting adventures. And to be an important part of contributing to the future of the United States and the world.

That is why most of us are in education. That is why we pour our lives into universities. And I see this as new ideas—new possibilities; and I applaud what Phil Needleman, and Dave Kipnis and their colleagues are doing.

We will not know, in one sense, how effective this has been for another generation. But if we do not do things like this—if we do not try them, we are dead.

Dr. **Needleman**. The issue is critical mass. I think a university wants to build a critical mass of scientists or scholars to be the cutting edge.

We do not want to go from one, to two, to three, to five even. We want to be able to go from two to five. We want the best people, the best ideas, the best facilities. I want the best students.

When I interview a post-doc or a pre-doc to come into my laboratory, I know what I should ask them is what are you going to teach me?

When you have an adequate body of scholars with the right support facilities, you create an environment of constant challenge.

So where will the ideas come from for the discoveries and from the inventions? Well, there's journals, and there's colleagues, and there's collaborations. And you have to do everything you can to build the environment.

Where we have suffered is where—when we have not had a critical mass. And so the industry input, for example in this case, brought us a level of technology which we would have never invented. We would have never done, you know.

We would be interested in the single discovery not the family discoveries. It enriches the chances for the scholars in the university to have a bigger dream.

That is why we work so hard. What the university provides is a space and some salaries, and kind of an environment and a commit—and it removes barriers so that the scientist alone is the only limiting step.

So this industrial interaction really allows to be a best. You might argue about opening up things to a variety of countries or people.

What we are really interested in is bests, I think. And bests that push us to higher levels. And so it is not more complicated than that.

We have been able to do things that just were not achievable before.

Mr. **Walgren**. That is sort of like adding outside resources, is it not? I mean, is that what you are mostly pointing towards now?

Dr. **Needleman**. It adds outside resources but it adds technologies that we did not have and collaboration that we did not have.

This hormone I have found is 126 amino acids. That is so big that there is no way that I could manufacture it in my laboratory to study except grinding up individual hearts.

Yet Monsanto, because together we discovered the gene, can stick it into bacteria and grow it in vats; and makes me kilogram quantities of that hormone.

Then I could take it back with my students and my fellows, and we figure out how does the body clip it? How long does it live in the body? Where is it destroyed? What is its mechanism of action?

Could not have done it without them.

Mr. **Walgren**. And I suppose that becomes more true as you get into a cross-disciplinary, if that is the word of art these dates—meaning, to be able to have access to resources that may not be right in the channel that you are working with.

Dr. **Danforth**. Can I just add that we were talking during the break about one of the problems. And that is how does one have some spread of the support of science and scientific facilities around the country.

It is—the reason it is such a problem is that the critical mass necessary for really good science is getting larger.

You cannot do it with a handful of people anymore. That is too much of a generalization. But biologic science depends upon very large central facilities—tissue culture and various kinds of analytic machinery; people to run the analytic machinery.

And it is a very expensive investment in the capital resources and in the human resources; and you cannot do that all over.

It is a tough, tough problem.

Mr. **Walgren**. Let me ask an unrelated question that you all shouldn't go without being asked.

Is there any way at this point—if you had a limited amount of dollars that apparently are available to us, would your attention first be drawn to instrumentation in support for university research, as opposed to the building of buildings?

Or is it your view that this has gone to the point now—the size of the facilities needed—that we must go to the building structural level of support for projects as opposed to smaller amounts of money that would support instrumentation?

Dr. **Danforth**. That is a very difficult question for me. My colleagues might have ideas. Let me say that, if I really had to opt for only one or only the other, I would probably opt for instrumentation, but the two go hand in hand.

Often the renovation and fixing up of facilities is a key part of new instrumentation. The huge magnets that one uses with MRI or NMR or research—require all sorts of special handling.

So the two really go together. You cannot have a good research establishment without both.

Mr. **Walgren**. Dr. Baue?

Mr. **Baue**. I would like to just add that, if you asked me for a priority, I would say that people development would be first. I see our major need in all of these relationships is to increase our support for the development of research scientists, both basic and clinical.

Many of us are concerned that we do not have now development in educational programs for clinical research scientists to help move these things that Dr. Needleman is developing in the laboratory on into the clinical arena where they could be evaluated, tested, and other exciting things done.

Equipment is necessary; the buildings are necessary. But Dr. Needleman said he is a bench scientist and what he needs is a bench and some equipment, certainly, and a roof over his head.

But unless we have the critical mass of people to develop exciting ideas, not much will flow.

Dr. **Needleman**. You put us in a no win position.

Mr. **Walgren**. We have been put in that ourselves. [Laughter.]

Dr. **Needleman**. It is like picking which child, I suppose. Instruments usually read from 0 to 100, however, for everyone. It is the question you ask—and people ask questions.

So if I had a rank order, I would have to say—agree with Art Baue that the nurturing of young scientists, and attracting them in, and letting them understand the joys comes fairly high, but the no loss position is they will have ideas that will be tested on big machines that get the answer so—but maybe they wiil be clever enough to help us both out in a loss position.

Mr. **Walgren**. Okay. Well, thank you all very much. You have been a good—made a nice contribution. And we appreciate it.

Let's join the last two panels together.

Mr. **Buechner**. I would like to remind all the various panelists that they are invited to join us for lunch. So before everybody scoots out, I wanted to have them kind of pencil that in on their schedules.

Mr. **Walgren**. Let's start then with Dr. Mitchell.

STATEMENT OF DR. ROGER MITCHELL, DEAN, COLLEGE OF AGRICULTURE, UNIVERSITY OF MISSOURI-COLUMBIA, COLUMBIA, MO

Dr. **Mitchell**. Thank you very much for the chance to join with you and Congressmen Buechner and Hayes in this conversation.

I am going to need to request the opportunity about 1:20 to excuse myself. There is a plane sitting over there that I hope to be on. And I do thank you so much for this——

Mr. **Walgren**. We apologize for that.

Dr. **Mitchell** [continuing]. Opportunity.

As my written testimony indicates, I serve as Dean of the College of Agriculture and Director of the Agricultural Experiment Station of the University of Missouri, Columbia.

To those of you responsible for our federal part of the partnership, we have just celebrated the Hatch Centennial, 100 years ago where William Henry Hatch sponsoring that federal legislation that started agricultural experiment stations.

From that kind of a combination of both basic and applied research, we have had the foundation to collaborate with industry for a long, long time.

In fact some of that early collaboration would be exemplified by the way in which, for example, in corn—a very important commodity to us all, Missouri station released the line that for a period of time was in over 12 percent of the commercial hybrids in the United States.

The estimate of an annual value added to farmers of $50 million because of that research experience.

And so that kind of activity has been going on. We have also been sharing, as the clinical discussion of the last panel would suggest, in evaluating the products of industry. Agriculture is very site specific; and things that work in Louisiana may not work in Pennsylvania or Missouri the same way.

So evaluating a product from a commercial firm in that site specific situation has been one of the strengths of our combined experiment station and cooperative extension activities over the years.

If you will, it is technology transfer into systems approaches in a very, very useful manner.

As we think today about the industry-university collaboration, the theme that has been underway of partnership is so very, very important.

And I wanted to spend just a few moments in focusing on how that partnership is built for successful and mutually beneficial relationships.

We have had extraordinary examples here of very large scale activities. And I would note that in effect I see those of us that are working in biological based—often with a key engineering and physical science component—relationships with industry, that we are building that capacity rather rapidly.

The previous examples that I cited were something different than I see developing in basic research projects at the present time.

For six years our campus has focused on two programs which have expanded our capacity and desire to collaborate with industry and educational and research partnerships.

These programs we would call Food for the 21st Century and Molecular Biology. The state of Missouri has recently made an additional annual investment of over $5 million in these two areas to compliment past on-going funding.

Faculty are generating over $25 million in grants in these areas of research. New facilities of over $25 million in value have been recently constructed on our campus that support biotechnology research and education.

I cite this history and funding levels as evidence of our increased capacity to effectively interact with industry in biotechnology research partnerships.

During this same six year period we have sought to enhance appropriate industry linkages. It is clear to me that industry needs to see that our state is also committed to investing in key targeted educational and research efforts.

That has happened, as noted above.

Second, industry finds it attractive that the comprehensive public research university campus has a wide range of disciplines which can and do contribute to new approaches to a specific problem area.

So the delicate but important blend between growth and depth is nurtured on the campus.

As university-industry partnership develops, the scientists need and have a chance to individually build trust relationships.

In the university there is also a necessary development—as we have heard it eloquently described today—of channels for procedural and legal counsel well understood by each faculty member.

I would just cite as a few examples experience we have had in relation to the Missouri Research Assistance Act. I have already mentioned to you the key partnership of the federal government.

Our state, in addition to their funding, for example, of the agricultural experiment station, has made this new funding available; and it has been very stimulatory, in fact, for seeking funds from private industry.

One particular firm, Merck and Company, has an interest in body composition of hogs in a research site near our campus. They have provided fellowships and operating funds which allow two professors to win these MRAA funds and total project funds of $114,000 for comparison and calibration of instruments used to determine body composition in live hogs.

A very practical, how much lean compared to fat ratio, in swine. And yet an activity that is going on at the basic level with industry colleagues.

One faculty member who held a post-doctoral appointment at Monsanto before joining the Biochemistry faculty at the University was awarded a gift as well as equipment from Monsanto that allowed her to develop a $192,000 grant out of the MRAA funds for studying the utilization of transgenic plants to study the effects of cytokinin on plant growth and development.

Effectively, to understand what controls the genes that relate to heat stress, or other climatic stress, is very common in our part of the United States.

It is important to note that in each case above students were involved, thesis research generated, and industry scientists interacting as the work progressed.

As an annual experience supporting the Food for the 21st Century program, industry, government, and other university scientists come to the campus to review research progress.

Over the past four years over 60 industry scientists have participated in such reviews. This has been another key step in building new relationships toward education and research programs of mutual interest.

Third, I would cite a recent retreat between faculty in Monsanto, or the university, and the experience there of the manager of the Monsanto physical sciences center, noting that there would be the opportunity for our researchers to use a very valuable X-ray diffraction and "high mass" mass spectrometry instrumentation.

Such interaction will allow us to employ high quality new faculty—we are recruiting two at the present time—and not devote an inordinate amount of our resources to such sophisticated equipment.

In return, Monsanto will obtain another colleague or two to utilize their excellent and expensive equipment just two hours down the interstate.

Finally, I would cite that on our side we have some very valuable university facilities. It comes from one of the scientists a long time ago working on bioenergetics.

Environmental chambers where temperatures can be controlled experimentally, and cows or other farm animals studied for temperature and other interactions.

One collaborative study recently has been with Monsanto evaluating their bovine somatotropin in which they have invested large sums of money in learning more about its milk production under a wide range of controlled environmental temperatures.

I just want to say a special thanks to this panel for coming and sharing with us to express to you that the federal-state partnership has been a very special one for 100 years; that the expanded opportunities to work with industry in basic relationships.

And I like you have been inspired this morning to see other examples that are farther down the road. But we believe that we are building a foundation to do that in an ever-expanding way as well.

Thank you very much.

[The prepared statement of Dr. Mitchell follows:]

U.S. House of Representatives

Committee on Science, Space and Technology
Field Hearing on University/Industry Alliances

University of Missouri - St. Louis

Roger Mitchell
Dean, College of Agriculture
Director, Agricultural Experiment Station
University of Missouri-Columbia

Congressman Jack Buechner very appropriately noted in his personal letter of invitation that this hearing is an opportunity to examine industry-university partnerships.

It is our experience that a focus on the partnership is key to successful and mutually beneficial relationships.

Those of us working in public research, land-grant universities have enjoyed long-standing working relationships in providing a portion of the knowledge base for putting the products of industrial and agribusiness firms to work for food producers and processors.

Our relationships in joint collaboration on the development and education of new scientific personnel, as well as specific basic research projects have accelerated in the past few years.

The Missouri Agricultural Experiment Station has provided a basic and applied research emphasis to complement graduate education in the application of biological, engineering, physical and social sciences to problems of food and agriculture. Our colleagues in Biology, Medicine and Biochemistry, as well as many other disciplines have been important collaborators in building the foundation for our educational and research base.

During the past six years, our campus has focused on two programs which have expanded our capacity and desire to collaborate with industry in educational and research partnerships. These programs are Food for the 21st Century and Molecular Biology. The State of Missouri recently made an additional annual investment of over $5 million in these two areas to complement past, ongoing funding. Faculty are generating over $25 million annually in grants in these areas of research. New facilities of over $25 million in value have been recently constructed on our campus that support biotechnology research and education.

I cite this history and funding levels as evidence of our increased capacity to effectively interact with industry in biotechnology research partnerships.

During this same six-year period, we have sought to enhance appropriate industry linkages. It is clear to me that industry needs to see that our state is also committed to investing in key targeted educational and research efforts. That has happened as noted above.

Secondly, industry finds it attractive that the comprehensive public research university campus has a wide range of disciplines which can and do contribute to new approaches to a specific problem area. So a delicate but important blend between breadth and depth is nurtured on the campus.

As a university-industry partnership develops, the scientists need and have the chance to individually build a trust relationship. In the university, there is also a necessary development of channels for procedural and legal counsel well understood by each faculty member.

For the University of Missouri-Columbia, certain examples of developing relationships can be cited as follows.

1. The Missouri Research Assistance Act (MRAA), provides, on a competitive basis, one state dollar for each two private dollars in support of research that will benefit economic development.

   a. Merck and Company have an interest in body composition of hogs and a research site near our campus. They provided fellowships and operating funds which allowed Professors Jerry Lipsey and Harold Hedrick to win MRAA funds and total project funds of $114,500 for "comparison and calibration of instruments used to determine body composition in live hogs."

   b. Dr. Jill Winter, who held a postdoctoral appointment at Monsanto before joining the Biochemistry faculty at UMC, was awarded a gift and equipment from Monsanto that allowed her to develop a $192,673 (including MRAA funds) project on "the utilization of transgenic plants to study the effects of cytokinin on plant growth and development."

It is important to note that in each case above, students were involved, thesis research generated and industry scientists were interacting as the work progressed.

2. As an annual experience supporting the Food for the 21st Century program, industry, government and other university scientists come to the campus to review research progress. Over the past four years, over 60 industry scientists have participated in such reviews. This has been another key step in building new relationships toward education and research programs of mutual interest.

3. We anticipate the opportunity for indepth retreats with industry scientists from time to time. One such retreat in the summer of 1987 with a group from Monsanto and UMC generated broad based discussion and exciting evaluation of common research interests.

In particular, focus developed on UMC's plan to employ researchers to study the structure of macromolecules (proteins, DNA, RNA). Monsanto is also vitally interested in the area and has established an excellent facility for physical chemical instrumentation. Dr. John Putsinger, Manager of the Monsanto Physical Sciences Center, offered the opportunity for our researchers to use this very valuable X-ray diffraction and "high-mass" mass spectrometry instrumentation. Such interaction will allow us to employ high quality new faculty and not devote an inordinate amount of our resources to such sophisticated equipment. In return, Monsanto will obtain another colleague and collaborator to utilize their excellent and expensive equipment.

4. The University of Missouri-Columbia has an outstanding new Animal Sciences Center. Included here, and building on the history of Dr. Samuel Brody's classic work in bioenergetics, are environmental chambers when temperatures can be controlled experimentally and cows or other farm animals studied for temperature and other interactions. One collaborative study recently completed allowed Monsanto to evaluate bovine somatotropin and milk production under a wide range of controlled experimental temperatures.

5. Undergraduate students also benefit by interactions with industry while studying for the Bachelor of Science degrees. Two unique program activities in this regard are:

a. The John Brown Scholars - Sixteen undergraduates spend a week in St. Louis with a wide range of businesses including Anheuser Busch, Merchants Exchange, trade associations and Schnuck's to learn firsthand about the full range of food processing, marketing and merchandising.

b. A Food Science course offered at the advanced undergraduate level has 12 hotel and restaurant managers instructing in the course.

In addition, a group of 25 students shared in a week in St. Louis to see hotel and restaurant management firsthand.

To conclude this statement, I would offer the following responses to the specific questions asked in the Hearing Charter:

1. What is the role of the state government in fostering university-industry cooperation.

-- To provide an atmosphere of official encouragement by public statements and policy.

-- To provide funding that allows the University to be a fiscally responsible, as well as an intellectual partner.

-- To provide a forum where interested parties can meet.

2. What factors are causing the increasing interest in such cooperation? What are the barriers to expanding cooperation? What criteria should companies and universities use in determining whether a partnership is productive?

-- Increasing interest is due to a growing recognition of the benefits of collaboration including idea generation and creativity, as well as effective use of expanded equipment can be enhanced by such cooperation. U.S. businesses and academic communities fully recognize that we must join forces in order to meet competition in the international arena.

-- The first barrier is that time and effort has not been invested sufficiently to know each other. Following that, for public universities, there is often a limited fiscal resource base on which to build full partnership.

-- A productive partnership will be evident from key examples of how the collaboration enhanced creativity and produced new products that compete effectively in the world's markets.

3. What has the economic impact of cooperation been at both the state and national levels? What is a sufficient amount of time to evaluate the productiveness of such relationships?

-- No specific economic impact is cited from these experiences to date. But one could cite the case of a university released inbred line of corn, MO 17, used widely in private corn hybrids and which for a period of two decades provided an estimated $50 million annual increase in corn production for U.S. farmers.

-- These are long term projects. It will often take ten years to properly evaluate them, however, an examination at 2-3 years and 5-7 years should allow one to give a continue-not continue response.

4. How can smaller companies take advantage of university expertise?

-- The Missouri Corporation for Science and Technology sponsors four innovation centers in the state. These are in Columbia, Kansas City, Rolla and St. Louis. In addition, the Small Business Innovation Research fund is available through a Federal-State collaboration. Small companies can tap university-derived innovations through this system. Small business support in Agriculture is also available through the USDA-Cooperative State Research Service.

5. Should government or universities seek to limit the involvement of foreign companies with university research? Should government require that such research help produce or retain jobs in the U.S.?

-- The agribusinesses involved in agriculture are generally multinational. Some are based in the U.S., some in other countries. Our food and agricultural systems benefits by research done elsewhere. We will benefit others by what we do. Industrial corporations will move the new products and processes to places that can benefit food and agricultural production. There should not be a limit on foreign companies in university research or on our companies doing research in other countries. We all benefit from the synergism. Care is needed in developing the relationships. Arrangements are being effectively developed which do not impede the publication of data, and patent agreements are carefully and thoughtfully developed.

-- Jobs will be created as we are competitive in a global marketplace. Government needs to facilitate that capacity to compete, not to artificially control.

RLM/lmh

Mr. **Walgren**. Thank you very much, Dr. Mitchell. And if you have that plane to go to I would be, certainly, understanding myself; and I know that others would as well.

Mr. **Hayes**. In fact, I would like to ride with you. I have got to go to the airport; you seem like a good source. That would give me an opportunity to—I think it is outrageous that the university increased corn production.

I have been seeing it stacked up in Iowa for months now. I knew someone was at fault. And now I have found the source of that fault. [Laughter.]

Mr. **Buechner**. I'd like to see something else stacked up tomorrow—from the results of consuming corn.

Mr. **Walgren**. Well, why don't—I would certainly understand if that plane calls, you feel free to slip away whenever you feel you need to.

And let's then turn to Dr. Jischke.

STATEMENT OF DR. MARTIN C. JISCHKE, CHANCELLOR, UNIVERSITY OF MISSOURI-ROLLA, ROLLA, MO

Dr. **Jischke**. Thank you, Mr. Chairman, members of the Committee. I am Martin Jischke. I serve as Chancellor of the University of Missouri, Rolla. I want to join the others in welcoming those of you from outside of Missouri to our state.

It is a special pleasure and an honor for me to speak on the role of universities in the economic development of small businesses.

And whether one refers to Route 128 in Massachusetts, where I went to graduate school, Silicon Valley in Northern California, Atlanta, or wherever, it has become increasingly clear that technological universities like UMR are playing an increasingly important role in the economic competition that we all face.

We are now in a knowledge based economy. And I would argue that in that kind of economy education is the basic industry.

At a time when science and technology are reshaping the economic landscape, technological research universities like UMR are increasingly critical ingredients in a state's ability to grow and prosper.

It is also clear that small businesses continue to be responsible for much of the nation's employment growth. President Reagan's annual report on the state of small business says that employment in small business dominated industries grew by 2.9 percent—almost 8 times the rate of growth in large business dominated industries.

That 2.9 percent represents 1 million jobs. Certainly universities indirectly support small businesses, indeed, businesses of all sizes, by graduating men and women who are prepared for the challenges of the 21st century.

But today I would like to take just the few minutes I have and talk to you about more direct and specific ways in which universities like UMR can assist the economic development of small businesses.

These ways include the following: first, helping small business keep track of changing technology; second, by assisting them in solving their specific problems; and third, by conducting research that advances technologies—for example, automated manufacturing that will turn out to be pivotal to the future of small business.

And because the university of Missouri-Rolla is actively engaged in each of these, I would like to try to illustrate some of these areas with examples from our campus.

First, let's look at keeping track of advancing technology. UMR has a center for economic transfer and economic development that seeks to enhance Missouri's economic growth in a variety of ways.

Technical information, for example, is easier for small business in Missouri to obtain through a technology search program we have at the university.

This effort has provided businesses with information such as patent information on remote control traffic signal devices, state of the art updates on electrostatic printing techniques, regulatory information on warning labels, and so on.

The university has access to 300 high speed commercial and governmental data bases that provide a wealth of information that is accessible to small business.

And we use the NASA recon system to do this. We have been working with literally hundreds of small businesses throughout Missouri in providing access to this data base.

Clearly one of the ways we keep businesses—small and large alike—aware of advancing technologies through educational programs in addition to a program in Rolla which is about 100 miles south and west of here.

We have a program right here in St. Louis at the graduate level in which we provide opportunities for working engineers to pursue graduate level education.

We also have installed satellite and fiberoptic communications systems that allow us to begin to take these educational programs literally anywhere in the state or the country, for that matter—anywhere there is a dish, and a down-link capability.

And the costs of doing that are coming down to the point that that will become, I believe, an increasingly important way of keeping our work force abreast of the rapidly changing technology.

Helping small businesses' specific programs is a second area in which universities can have an impact. Small businesses typically do not have R&D staffs. They cannot afford them. And occasionally they are challenged by particularly knotty technical problems where if there is a mechanism for gaining access to university research capabilities solutions can be developed.

And I would like to give you just one small illustration that happened right here in Missouri in a town called Cuba, Missouri.

It is a town of about 2100. They have a small company there called Bronze Fabricator which makes cauking compounds. Their major account is Walmart, which is a sizable account.

And one day Walmart found out that the filler in the cauking was asbestos. Took the product off the shelf; and to quote the president of bronze fabricator, "It was a significant emotional event."

The small company of about 25 people was in deep trouble. Luckily, someone in Cuba know about the University of Missouri-Rolla; brought the president of this company to our chemistry department where they met Jim Stoffer, who is an excellent polymer chemist; Jim took a look at the problem.

In a matter of a couple, three days he and his colleagues and students were able to find a substitute filler for the asbestos.

The company figured out how to manufacture the cauking with the new filler; and they are back in business doing quite well, thank you.

An interesting and important illustration of how access to what turns out to be rather specialized expertise—in this case, in polymer chemistry, really is the basis for the survival of a small company right here in our state.

There are other examples.

One of the keys to the success of that kind of effort is a marketed effort on the—by the university creating the linkages so that when people have these problems they are brought to the university and they begin to look for help, turns out, I think, to be the real linchpin in all this.

And we are working hard at that. We have actually people in our Center for Technology Transfer and Economic Development that are assigned to that marketing effort.

A third way in which universities can help small businesses is through advancing technologies that are important to competitiveness and innovation.

And along this line we have what we think is a particularly exciting development at the university called the Manufacturing Research and Training Center.

The goal of the center is to improve Missouri's manufacturing competitiveness by bringing in industry, university and government resources together to solve manufacturing problems and also to increase the rate at which new technology is implemented in manufacturing.

This center will help manufacturers, particularly support the medium sized companies, by providing training with factory to future equipment that is used in modern manufacturing and by supporting basic R&D in the improvement of manufacturing.

Companies will be able to come to the center with a product concept; collaborate with people on the campus in the design of the product; develop the manufacturing processes; and then test those processes by producing the product in small quantities before they have to make the decision to commit capital for a new facility.

We believe that this center can only happen if we pool our resources, that is through a consortium of university, business, and government programs.

This is one of the reasons why we support the proposal for the national Bureau of standards to develop manufacturing demonstration centers, and also the program of centers for advanced technology here in Missouri.

I believe the federal government can help universities like UMR address the needs of small businesses by supporting the basic educational infrastructure that underlies this effort.

Specifically, I have three suggestions. One—absolutely fundamental—continued support for basic research through the National Science Foundation and the National Institutes of Health, and so on.

This provides the basic knowledge base that allows us to serve the small businesses. I am particularly concerned, as an engineer, with the need for additional support of research that deals with process technologies—manufacturing in particular.

And I am also terribly concerned about support for graduate students in the fact that too few of our own children are going on to graduate school to become the pool from which the faculty of the future will be drawn.

The issue is deadly serious for universities. Second, I believe you can foster access to technical information by the continued support of the NASA recon system, and by support of technology transfer programs at universities.

The precedent exists for such an effort in the cooperative extension program supporting agriculture.

And third, I would encourage you to expand support for consortia that bring together small businesses, university and government to tackle problems that are important to small businesses: proposed manufacturing demonstration—center program at MBS is a great example of this; engineering research programs at NSF are another.

My real worry is do you think you can really address the needs of this country to 15 of them? The program is far too small to have an impact across the United States.

I think the evidence is that they are successful and they can have a dramatic impact. But it is a drop in the bucket with 15.

I would be happy to answer questions later.

[The prepared statement of Dr. Jischke follows:]

Chancellor Martin C. Jischke

Testimonial

Congressional Subcommittee on Science, Research, and Technology
February 8, 1988
St. Louis, Missouri

It is a pleasure and a privilege to join my distinguished colleagues on this panel of the Congressional Subcommittee on Science, Research, and Technology.

It is a special honor to speak on the "Role of Universities in the Economic Development of Small Businesses."

Whether you are talking about Route 128 near Boston, the Golden Triangle of North Carolina, Silicon Valley in Northern California, or Atlanta, it is clear that technological universities play an important role in the new competition for economic progress. And, institutions of higher education play their role with small businesses as well as with large corporations.

Whatever the partnership, both universities and industries must recognize that the structure of our economy is undergoing profound and irreversible changes.

Modern communications and transportation have thrust us into an internationalized economy whose impact on Missouri and the nation is substantial. From the automobile industry to agriculture to banking, the competition from abroad is restructuring our economy and making clear that the old ways of doing business will not suffice.

If the United States is to sustain its relatively high standard of living, the nation must increasingly compete with its knowledge and its technology rather than its abundant natural resources.

We see the early evidence of this shift to a knowledge-based economy in the emergence of large numbers of small, technologically-intensive businesses and the growth of the service sector of our economy. Communities across the state of Missouri, both urban and rural, are calling for increased access to engineering and scientific education as they seek to better respond to economic opportunities of the future.

How this knowledge-based economy will continue to evolve is, as yet, unclear. What is clear, however, is that education is the basic industry of a knowledge-based economy. Providing educational opportunities that are appropriate to higher education and that are responsive to this changing economic environment will challenge all universities.

And this challenge involves the cooperation of higher education with industry--both large and small businesses.

Today, I would like to focus on small businesses, as they continue to be responsible for much of the nation's employment growth.

President Reagan's annual report on The State of Small Business, says that "employment in small-business-dominated industries grew by 2.9 percent, almost eight times the rate of growth in large-business-dominated industries at 0.4 percent during 1986." That 2.9 percent employment gain over all small-business-dominated industries represents more than one million jobs.

Indeed, small businesses are among the leaders in our nation's employment growth. Certainly, universities support small businesses by graduating men and women who are prepared for the challenges of the twenty-first century. But, today, I would like to take a few minutes and talk with you about three other ways in which universities can assist the economic development of small businesses.

These ways include: helping small businesses keep track of advancing technology; assisting small businesses in solving problems; and advancing the knowledge of successful automation and other innovative programs which can be adapted to small businesses.

And, because the University of Missouri-Rolla is so involved in each of these areas, I would like to use our campus as an example.

First, let's look at keeping track of advancing technology.

UMR's Center for Technology Transfer and Economic Development enhances Missouri's economic growth in many ways. Technical information, for instance, is easier for small businesses to obtain through a technology search program at the center.

For example, the program has provided businesses with patent information on a remote control traffic signal device, state-of-the-art updates on electrostatic printing techniques, and regulation information on warning labels for consumer products. Indeed, the 300 high-speed commercial and governmental databases provide just about any information which small businesses might need. And, the principal governmental network used by the program, the NASA RECON System, allows small businesses easy access to technical data.

Bringing educational programs in engineering and science to urban areas is another way to keep small businesses technologically current.

Nearly 700 residents of the Greater St. Louis Area, for example, are pursuing master's degrees at the UMR Engineering Education Center located on the University of Missouri-St. Louis campus. And, through videotaping and satellite communication capability, UMR's Video Communications Center extends programs to working engineering professionals around the state.

Helping small businesses solve specific problems is another way in which universities can have an impact.

UMR has contributed through its research and service mission to the economic development of small businesses in many locations.

For example, in Cuba, Mo., a UMR chemistry professor worked with the Bronze Fabricator Company in developing an asbestos-free caulking compound. And, in St. Louis, UMR researchers have assisted in the product development of an engineered tennis racket, worked on samples of reflector tape, assisted in the development of a new piece of dentistry equipment, and have carried out polymer chemistry analyses.

Many companies benefit from the Small Business Development Center at UMR which assists by evaluating inventions, counseling entrepreneurs, and encouraging new products.

A third way in which universities help small businesses is by advancing their knowledge of automation.

Along this line, an exciting new development is occurring at the University of Missouri-Rolla. A Manufacturing Research and Training Center is being established whose goal is to improve Missouri manufacturing competitiveness by bringing together university, industry and government resources to solve manufacturing problems and to increase the rate at which new design and manufacturing technology is used.

The center will provide manufacturers access to the information, technologies, and personnel needed to solve manufacturing problems. And, we believe it will play a pivotal role in expanding the economy of the state.

The center will help manufacturers in their automation through providing training with factory-of-the-future equipment used in modern manufacturing; supporting basic research and development in improvements of manufacturing; and providing a state-of-the-art flexible manufacturer-system to demonstrate this new technology.

Companies will be able to come to the center with a product concept, design the product, develop the manufacturing processes, and produce the product in small quantities before they purchase capital equipment--an example of possibilities which can be realized from pooled resources.

We are very excited about the possibilities the center will provide. Plans are now being finalized, and a formal announcement will be made next month.

This, then is a brief look at the university-industry links which can benefit small businesses.

Whether it be continuing the education of professionals or keeping current on information, solving problems, or advancing know-how, universities and industries can work together to enhance our economic outlook.

As we approach the year 2,000, universities and small businesses can cooperate in creating an environment for economic growth and in enhancing the position of our state and nation at the leading edge of change.

Mr. WALGREN. Thank you very much, Dr. Jischke.
Mr. Johnson.

STATEMENT OF JOHN S. JOHNSON, MANAGER, HIGH TECHNOLOGY PROGRAM, MISSOURI DEPARTMENT OF ECONOMIC DEVELOPMENT, JEFFERSON CITY, MO

Mr. JOHNSON. Thank you, Mr. Chairman and members of the Committee, I welcome you to St. Louis and the state of Missouri.

My name is John Johnson. I am Manager of the state of Missouri's High Technology Programs, and I also serve as the Executive Director for the Missouri Corporation of Science and Technology.

The high technology programs are administratively part of Missouri's Cabinet level Department of Economic Development. And there is an important linkage between the State's economic development activities and high technology initiatives. And that is going to be the focus of my comments to this particular Committee.

The state of Missouri really focused on high technology efforts in 1983, and it did this by creating the Missouri Corporation for Science and Technology.

This not-for-profit Missouri Corporation is governed by an 18 member board appointed by the governor with six members from the public sector, six members representing private business and labor, and six members from education.

Some of the members of the—in fact, the balance of this committee are all members of the Science and Technology Corporation.

The exclusive purpose of the corporation is to contribute to the strengthening of the State's economy by fostering the development of science and technology.

Missouri Corporation emphasizes this goal promoting the State's future economic growth by supporting and nurturing scientific research and advance technology companies.

One of the first programs which the state of Missouri adopted based on recommendations from this corporation was that of innovation centers.

An innovation center is designed to create an environment of support and assistance for innovator and entrepreneurs involved in various stages of bringing new products or processes to market.

Special emphasis is given to firms in the high technology areas. There are four innovation centers located in the state of Missouri. Now they're receiving an annual state appropriation of approximately 1.6 million.

The centers are located in St. Louis, Kansas City, Columbia and Rolla. Just to give you an idea about some of—the performance of these centers over the last two fiscal years, as far as the dollar value of the client projects—what they developed—it's 18.1 million.

The clients within these centers have annual sales of 18.6 million; an annual payroll of Missouri individuals of 8.4 million.

And they have generated 264 new jobs, as well as maintained an on-going 365 jobs.

The question to the Committee earlier revolved around statistics as far as have they been successful. The state of Missouri has planned these centers to be funded at a level of 8 to 10 years, and after that time they are going to be self-sustaining.

We did not start to generate statistics until this year, and a lot of it is in response to the legislature's request for—what have we put, or the $6 million that we put in the program.

The numbers have jumped dramatically. There has been about a 75 to 100 percent increase this year as opposed to last year.

And we are in the fourth year of the program—really the third full year of operation.

Another program which the corporation oversees is higher education applied projects.

Mr. **Walgren**. To underscore there, you are getting a $6 million investment. Almost 2 million is coming back in one year.

Mr. **Johnson**. That is over a two-year period—that is a two-year——

Mr. **Walgren**. It is a two-year period.

Mr. **Johnson**. That is a two-year period.

Mr. **Walgren**. But you are getting four-year payback on your total public investment, and then——

Mr. **Johnson**. That is correct.

Mr. **Walgren** [continuing]. Everything after that is increased benefit.

I am sorry.

Mr. **Johnson**. Another program which the corporation oversees is higher education applied projects. This is a challenge grant competition with a maximum 2 to 1 public to private dollar match for small businesses participating in the program.

The projects focus on applied research conducted through any higher education institution in Missouri except the University of Missouri system.

The university of Missouri system has the Research Assistance Act which was referred to earlier. The definition of an applied project is any activity which seeks to utilize, synthesize or apply existing technol—knowledge or information, or research—resources toward the resolution of a specified problem, question or issue.

To date, 14 grants have been given under this program totalling 1.2 million in state dollars; and these grants have been matched by private companies in the amount of 1.2 million.

I should add that an additional four million state appropriations has been put into the Missouri Research Assistant Acts which involves grants for the University of Missouri system.

Well, the most exciting programs that the corporation is implementing is what we call our Centers for Advanced Technology.

These centers are designed to encourage greater collaboration between private industries and universities in the state, at these centers, to be located on university campuses.

Business and university researchers will conduct basic and applied research in specified high technological areas.

The corporation is in the process of evaluating 12 proposals submitted for designation as a Center for Advanced Technology. And we expect to make several awards in the next month.

A point I would like to make with regards to the centers is that many of the universities that have submitted applications are also applying for federal funds such as the NSF Science and Technology Resource—Research Centers.

The state of Missouri is requiring that no more than 50 percent of the funding can be from state sources. This is an excellent opportunity to leverage federal, state and private dollars in scientific and technological areas.

The state of Missouri has also appropriated 15.5 million dollars for the establishment of two university research parks: Missouri Research Park in St. Louis, and the University Park at Kansas City.

These parks were offered tenant's access to university facilities and education resources, including libraries, information processes; things of that nature.

The last program which I wanted to mention that the state of Missouri has is our SBIR program. The SBIR program, as you are aware, requires the 11 participating federal agencies to set aside a portion of their R&D budgets for use by small businesses.

The state has staff people which promotes this program to businesses in Missouri. And to date 2.7 million dollars have come to the state through both phase I and phase II SBIR grants.

These are just a highlight that some of the programs that the state of Missouri has.

I have also given to you an annual report of the corporation which goes into a little more detail on these programs.

Thank you.

[The prepared statement by Mr. Johnson follows:]

STATEMENT OF JOHN S. JOHNSON

TO THE HOUSE COMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

February 8, 1988, St. Louis, Missouri

Mr. Chairman, members of the committee, thank you for inviting me to testify and participate at this important hearing. My name is John Johnson and I am the Manager of the state of Missouri's High Technology Programs as well as being the Executive Director of the Missouri Corporation for Science and Technology. The High Technology Programs are administratively part of the state of Missouri's cabinet level Department of Economic Development. There is an important linkage between the state's economic development activities and high technology initiatives and that will be the focus of my comments to this committee.

My background has been in economic development most of my employment history and I have seen some definite shifts in economic development programs in the last ten years. I was originally trained as a "smokestack chaser" and later directed a local county-wide economic development effort. It is nice to get the headlines of the new 500 job plant location, but the company that adds 25-50 jobs or the new start-up company to an area is just as important, if not more important, since it adds diversification to the economy. The really successful economic development programs do not overlook what is in their own back yard.

The state of Missouri first focused in on high technology efforts in 1983 when it created the Missouri Corporation for Science and Technology. This not-for-profit Missouri Corporation is governed by an eighteen member board appointed by the Governor with six members from the public sector, six members representing private business and labor, and six members from education. Several of the corporation members are testifying before the committee today.

The exclusive purpose of the Corporation is to contribute to the strengthening of the state's economy by fostering the development of science and technology. The Missouri Corporation for Science and Technology emphasises its goal of promoting the state's future economic growth by supporting and nurturing scientific research and advanced technology companies.

The Corporation represents Missouri's commitment to the future. In pursuit of its goal, the Corporation advises the Governor and the Missouri Department of Economic Development on programs and initiatives to enhance the development of science and technology in the state.

One of the first programs which the state of Missouri adopted based on the Corporation's recommendation was that of innovation centers. An innovation center is designed to create an environment of support and assistance for innovators and entrepreneurs involved in various stages of bringing new products or processes to market. Special emphasis is given to the needs of firms in advanced technology areas. There are four innovation centers in the state and Missouri has invested a total of $6.1 million in the program. The following are some of the results of the centers:

INNOVATION CENTER PERFORMANCE STATISTICS

Dollar value of all client projects	$18.1 million
Annual Sales Forecast for all client companies	$18.6 million
Annual Payroll for all client companies	$8.39 million
Project 1987-88 Tax Revenue for Missouri from client companies	$ 1.8 million
Missouri employment created by projects of client companies	264 jobs
Missouri employment maintained by ongoing projects of client companies	365 jobs

The centers are in their fourth year of operation but are designed to be self-sustaining after an eight to ten year period and will no longer need state subsidies.

Another program which the Corporation oversees is Higher Education Applied Projects. This is a challenge grant competition with a maximum two-to-one, public to private dollar match for small businesses participating in the program. The projects focus on applied research conducted through any higher education institution in Missouri except the University of Missouri system. The University of Missouri system has the Research Assistance Act administered by the State Coordinating Board for Higher Education. The definition of an applied project is "any activity which seeks to utilize, synthesize, or apply existing knowledge, information, or resources to the resolution of a specified problem, question or issue."

To date, fourteen grants have been given under this program totalling $1.2 million in state dollars and these grants have been matched by private companies in the amount of $1.2 million. I should add that an additional $4 million in state appropriations has been put into the Missouri Research Assistance Act which involves grants for the University of Missouri system.

One of the most exciting programs that the Corporation for Science and Technology is implementing is what we call the Centers for Advanced Technology. These centers are designed to encourage greater collaboration between private industries and universities in the state. At these centers, to be located on university campuses, business and university researchers will conduct basic and applied research in specified high technological areas. The Corporation is in the process of evaluating 12 proposals submitted for designation as a Center for Advanced Technology and we expect to award our first centers in the next month.

A point I would like to make with regards to the Centers, is that many of the universities that have submitted applications are also applying for federal funds such as the National Science Foundation Science and Technology Research Centers. The state of Missouri is requiring that no more than 50% of the funding can be from state sources. This would be an excellent opportunity to leverage federal, state and private dollars in scientific and technological areas.

The State of Missouri has also appropriated $15.5 million for the establishment of two university research parks, Missouri Research Park in St. Louis and the University Park at Kansas City. These parks will offer tenants access to university facilities and education resources, including libraries, information processing, conference facilities, and professional staff and faculty.

The last program which I want to mention that the state of Missouri has is our Small Business Innovative Research or SBIR program. The SBIR program, established in 1982, requires eleven participating federal agencies to set aside a portion of their research and development budgets for use by small businesses. Staff people from the state are promoting this program to businesses in Missouri and to date $2.7 million has come to Missouri small businesses through Phase I and Phase II SBIR grants.

Mr. Chairman, these are just the highlights of the high technology programs in Missouri. The state is committed to growth and without these programs as part of the state's economic development efforts, the success would be limited.

BIOGRAPHICAL SKETCH

John S. Johnson

John S. Johnson has been employed at both the state and local levels in economic development activities since 1977. He was appointed to his present position as Manager of the State of Missouri's High Technology Programs and Executive Director of the Missouri Corporation for Science and Technology in March, 1987.

Mr. Johnson has a bachelor's degree in political science from the University of Missouri, Columbia, and was designated a Certified Industrial Developer (CID) by the American Economic Development Council in 1983.

Mr. **Walgren**. Well, thank you very much, Mr. Johnson. We appreciate that.

And I cannot help but sort of feel I should apologize to all of the witnesses for the fact that the time has gone on. But we are here for you.

And I appreciate particularly, Dr. Phillips, your staying. I know that there was a conflict earlier that was somewhat resolved.

But thank you for staying. And please proceed.

STATEMENT OF DR. WILLIAM PHILLIPS, SCIENCE ADVISER TO THE GOVERNOR OF MISSOURI, JEFFERSON, MO

Dr. **William Phillips**. Well, thank you, Mr. Chairman and members of the Committee for visiting with us in St. Louis. And I very much appreciate the opportunity of testifying here.

Just to give a little bit of my background, I am currently Science Adviser to the Governor. Until recently I was Vice President of Science and Technology of Mallinkrodt.

Prior to that, I was Chairman of the Department of Chemistry at Washington University. And prior to that, I was with the DuPont Company.

I bring only these points up to indicate that I have had my foot in both the academic and the industrial community so I feel I have a fair appreciation of this.

I would like to go over a few points very rapidly here today. Much has been said. I think it has been a very useful meeting from my standpoint, and I hope from yours.

But I will just make a few additional comments.

The United State possesses no greater asset than its research universities both private and public. They are the marvel of the world. They provide our industrial and government sectors with superbly trained people.

They generate the lion's share of the world's basic research result, a fraction of which are turned into products and processes.

The faculty of these universities are available for consultation with industry and government. Prior to World War II, many of our most promising students in the sciences went to Europe, primarily to Great Britain and to Germany, for their doctoral and post-doctoral training.

Now the reverse is true. Many of the World's most promising technical students are attracted to our universities and elect to remain in the United States because of superior opportunities in industrial or academic research here.

This point has been brought up before, but I think we must remember that one of the things that has made this country great is our ability to attract people from overseas with a great deal of talent.

I, like everyone else, deplore that more of our basic talents in the United States are not going into science and engineering.

Nevertheless, we do have this magnificent regulator of attracting people; and our universities—from outside the country—and our universities are playing an extremely important role, I think, in doing precisely this.

The quality of academic science and engineering in the United states is not the subject of this hearing. But the manner in which this invaluable asset is deployed and nurtured is.

At the outset, I would say that I believe university-industry alliances to be extremely healthy and beneficial to both parties.

Long range, relatively unfettered basic research is not an area in which industry is particularly well-suited temperamentally.

In this university's—in this area, universities shine. On the other hand, product and process development, whether it be long-range or short-range, is clearly the problems of industry.

Because of these different thrusts and expertises, interactions between universities and industry can result in great centers. That is one of the great strengths of this country.

What, then, are the problems and opportunities with regard to university-industry alliances, and how do we address them?

Industry supports universities in three ways. One is by the taxes they pay. The second might be termed their philanthropic contributions to universities from which good will, rather than tangibles, are primary expectations.

The third is through R&D alliances in which there should be at least the prospect for tangible returns to the corporation.

It is only to the later category that I will be referring subsequently. Most universities aspire to establish research relationships with companies. But many, frankly, do not possess the quality in facilities and/or faculty to make them attractive to industry with regard to potential R&D partnerships.

How was this quality obtained? There is only one way: investment in time and money.

Physical facilities, faculty salaries, faculty start-up funds and teaching loads must be appropriate to attract and retain superior faculty.

Only the state can provide such funds for their campuses. Remember here, I am referring primarily to state universities as—public university as applied to private. I will address that in just a moment.

Funding for instrumentation and research support for individual faculty can be obtained through federal agencies such as NSF, NIH, USDA, Department of Defense, and so forth.

But these are awarded on an appropriately tough peer review system. This peer review system must be continued. The last thing in the world we must fall into are geographical distributions, or if we want to build something up because it isn't so great here.

Ad hoc Congressional bills for construction of buildings or laboratory facilities, some of which we have seen in the recent past, are to be deplored.

There can be no question but that states that have invested heavily in—over a period of time—in their educational systems with emphasis on the research universities have reaped handsome rewards and attraction, generation, and maintenance of high tech industry.

These states include California, Texas, North Carolina, Arizona, Ohio, New York and Pennsylvania.

Should all states then levy the requisite taxes to enable them to bring their public universities to the point in quality where they can compete effectively with other states?

My own opinion is that they should not. Contrary to what many think, infinite opportunities do not exist for industry-university alliances, even for the best of our research universities that have been involved for some time in industry-university alliances—and here I include such universities as MIT, Cal Tech, Stanford, Cornell, Washington University, Carnegie Mellon.

Industrial contributions to the research base do not exceed 6 to 10 percent—actually a relatively small part, even with these universities that have been very, very deeply involved in such activities.

And the remaining 90 percent comes primarily from federal granting agencies.

We have in Missouri what is an unfortunate situation—not all of my colleagues would like this but—in that at the four major campuses of the University of Missouri, those located in the two main population, communication, manufacturing and transportation centers of the state, namely the University of Missouri at Kansas City and the University of Missouri at St. Louis, are the least developed of the state from a research capability point of view.

The rectification of this situation is through a real political minefield.

Let me briefly touch on three additional points. We are rightly concerned about the health of our state universities that have served the country magnificently and must continue to do so if we are to continue to prosper.

However, we must be equally concerned about the health of our private universities. On the topic of this hearing, namely, industry university alliances, such universities, again, as MIT, Stanford, Washington University, Cornell, Cal Tech, Carnegie Mellon, have pioneered.

Over the long-haul, these universities have striven for research excellence, and industry has sought them out. Their ability to move somewhat more freely from bureaucratic constraint has, I suspect, been an asset in the success story.

There is no question in my mind that—but that industry-university research alliances have been fruitful and should be fostered.

However, a strength almost unique to the American scene is that of the inventor and entrepreneur who has a product, process, idea and starts a new company to commercialize it.

Very often these small companies are off-shoots of universities or large companies. Herein, in my view, lies the country's best hope for innovative competitiveness.

We must not lose sight of this strength and do everything in our power to enhance it.

Finally, an increasingly advanced view is that this country's problems with respect to manufacturing competitiveness does not reside in our technologically—technological base, which arguably is the world's finest—but in our ability to compete in manufacturing costs and product quality.

I believe this to be the case. If so, the primary solution is improvement of the educational foundation of our work force at the primary, secondary and college levels.

U.S. business management could stand some education here as well.

Thank you.

[The prepared statement of Dr. Phillips follows:]

STATEMENT OF WILLIAM D. PHILLIPS
TO THE HOUSE SUBCOMMITTEE ON SCIENCE, RESEARCH & TECHNOLOGY
FEBRUARY 8, 1988
ST. LOUIS, MISSOURI

Mr. Chairman, members of the Committee, thank you for inviting me to testify at this hearing. I am William Phillips, Science Advisor to Governor Ashcroft and a Professor of Chemistry at Washington University. Until recently I was Vice President of Science and Technology at Mallinckrodt, Inc. and prior to that Chairman of the Department of Chemistry at Washington University and a Director of Research at E.I. duPont de Nemours & Co.

The U. S. possesses no greater asset than its research universities, both private and public. They are the marvel of the world. They provide our industrial and governmental sectors with superbly trained people. They generate the lions' share of the world's basic research results, a fraction of which is turned into products or processes. The faculty are available for consultation with industry and government. Prior to World War II many of our most promising students in the sciences went to Europe, primarily to Great Britain or Germany, for their doctoral or postdoctoral training. Now the reverse is true; many of the world's most promising technical students are attracted to our universities and elect to remain because of superior opportunities in industrial or academic research in the U. S.

The quality of academic science and engineering in the U. S. is not the subject of this hearing, but the manner in which this invaluable asset is deployed and nurtured is. At the outset I would say that I believe university/industry alliances to be healthy and beneficial to both parties. Long-range, relatively unfettered basic research is not an area in which industry is particularly well suited temperamentally; in this area, universities shine. On the other hand, product and process development, whether it be long or short-range, is clearly theprovince of industry. Because of these different thrusts and expertises, interactions between universities and industry can result in great synergy.

What then are the problems and opportunities with regard to university/industry alliances and how do we address them.

Industry supports universities in three ways. One is by the taxes they pay. The second might be termed their philanthropic contributions to universities fromwhich good will rather than tangibles are primary expectations. The third is through R & D alliances in which there should be at least the prospect for tangible returns to the corporation. It is only to the latter category that I will be referring subsequently.

Most universities aspire to establish research relationships with companies, but many frankly do not possess the quality in facilities and/or faculty to make them attractive to industry with regard to potential R & D partnerships. How is this quality attained? There is only one way: investment in money and time. Physical facilities, faculty salaries, faculty start-up funds and teaching loads must be adequate to attract and retain superior faculty. Only the state can provide such funds for their campuses. Funding for instrumentation and research support for individual faculty can be obtained through Federal agencies such as NSF, NIH and USDA, but these are awarded on an appropriately tough peer review system. Ad hoc congressional bills for construction of buildings or laboratory facilities such as we have seen in the recent past are to be deplored.

There can be no question but that states that have invested heavily and over a period of time in their educational systems, with emphasis on their research universities, have reaped handsome rewards in attraction, generation and maintenance of hightech industry. These states include California, Texas, North Carolina, Arizona, Ohio, New York and Pennsylvania. Should all states then levy the requisite taxes to enable them to bring their public universities to the point in quality where they can compete effectively with other states? I think not. Contrary to what many think, there are not infinite opportunities for industry/university alliances. Even for the best of our research universities that have been involved for some time in industry/university alliances (MIT, Caltech, Stanford, Cornell, Washington University), industrial contributions to the research base do not exceed 10%, the remaining 90% coming primarily from Federal granting agencies. We have in Missouri what is an unfortunate situation in that of the four major campuses of the University of Missouri, those located in the two main population, communication, manufacturing and transportation centers of the state, namely the University of Missouri at Kansas City and University of Missouri at St. Louis, are the least developed of the state from a research capability standpoint. The path to rectification of this situation is through a political mine field.

Let me briefly touch on three additional points. We are rightly concerned about the health of our state universities that have served the country magnificently and must continue to do so if we are to continue to prosper. However, we must be equally concerned about our private universities. On the topic of this hearing, namely, Industry/University Alliances, such universities as MIT, Stanford, Harvard, Washington University, Cornell and Caltech have pioneered. Over the long haul these universities have striven for research excellence and industry has sought them out. Their ability to move somewhat more freely from bureaucratic constraint has, I suspect, been an asset in this success story.

There is no question in my mind that Industry/University research alliances have been fruitful and should be fostered. However, a strength almost unique to the American scene is that of the inventor/entrepreneur who has a product/process idea and starts a new company to commercialize it. Very often these small companies are offshoots of universities or large companies. Herein, in my view, lies the country's best hope for innovative competiveness. We must not lose sight of this strength and do everything in our power to enhance it.

Finally, an increasingly advanced view is that this country's problems with respect to manufacturing competitiveness does not reside in our technological base, which arguably, is the world's finest, but our ability to compete in manufacturing costs and quality. I believe this to be the case. If so, the primary solution is improvement of the educational basis of our workforce at the primary, secondary and college levels. U. S. business management cound stand some improvement here as well.

Mr. **Walgren**. Thank you very much, Dr. Phillips. We appreciate that testimony.

And Mr. Sloan.

STATEMENT OF GEORGE SLOAN, VICE PRESIDENT FOR RESEARCH AND TECHNOLOGY, ST. LOUIS REGIONAL COMMERCE AND GROWTH ASSOCIATION

Mr. **Sloan**. Mr. Chairman, and Congressman Buechner, I want to thank you very much for coming out here and conducting this hearing on this important subject.

And I would like to complement the Committee on the manner in which it ordered the speakers, obviously saving the best till last. [Laughter.]

Thinking seriously, when I saw where I was on the agenda, and knowing the quality of the speakers who would precede me, occurred to me that nearly everything useful could be said on the basic questions posed by the Committee—would have been said when it came my turn.

So I am going to limit my comments to what the St. Louis Regional Commerce and Growth Association has done to try to promote economic growth in this area through industry-university cooperation.

And I might mention that in addition to being a Vice President of the RCGA I also have the—I work for the University of Missouri with the title of St. Louis Coordinator of the Missouri Research Park.

So my work, whatever it may be worth, is a product of university-industry cooperation.

And I would like to just say a word about the RCGA itself, because it is an example of industry-university joint action.

We have the heads of all the universities in the region on our board, as well as every segment of the economy. And in addition we have a science and engineering committee of about 40 scientists, engineers, engineering deans, and so forth, from which a lot of the programs that have been described here today have originated.

So, Mr. Chairman, I do think this committee might well commend to the attention of other communities RCGA's unique blend of business and academic activity as a model for encouraging industry-academic cooperation and support of economic growth.

Now in 1982, RCGA published a plan called High Tech Plan for St. Louis, which identified the characteristics of communities that have been successful in the area and measured St. Louis against these characteristics.

And as you brought it out in your opening remarks, Mr. Chairman, St. Louis is well-endowed in these areas.

But it is a fact that in certain areas we were not keeping up with the high tech trade. One of them was we were not a location where you had a lot of high tech start-ups; and another one, we had not attracted research activities from outside the region.

So we identified two programs to try to overcome that. First was the St. Louis Technology Center, an innovation center which has the mission of helping with high tech start-ups; and second, the

Missouri Research Park designed to attract research activities from outside the region.

Now both of these are joint university-industry operations. They both have nearly all of the universities that have testified here today and most of the large corporations represented on their boards.

I will just say a word about the high tech center. John Johnson already covered what has been done in the whole state. Our center here in St. Louis, for an annual investment of approximately $400,000, has leveraged $4,000,707, in private investment, which has created 108 jobs, generated $2,517,000 in salaries and resulted with a minimum of $181,00 annually in state and local taxes.

I think I should say that this really outstanding record—it has only been up and running for two years. It was accomplished through the fact that we have a really remarkable Managing Director, Gene Boech, who some of you may know.

Now the research park is located on 700 acres owned by the University of Missouri in St. Charles County. And the President of the University of Missouri has appointed a Board with all of the branches of the University of Missouri represented on that Board, as well as Washington University and several of the large corporations in the community.

This research park will provide a campus-like setting for research oriented activities from both the public and private sectors.

And it will provide strong ties to both public and private institutions for its tenants.

This outstanding location, strong university connections, and extra support from the public and private sectors surely is the success of this undertaking.

Ultimately, it is expected to generate many thousands of jobs for the St. Louis region. As of today, first phase development of the infrastructure is nearing completion. And we hope to break ground next week for the first time.

Normally it takes about 15 years for an activity like this to mature. Fifteen years from now I will be 97 years old; so I do not expect to be on hand to watch what is going on.

But we really have gotten out to a good start, and we are very pleased with what is happening.

Well, Mr. Chairman, this is two of several programs that the RCGA is promoting. And we are proud to be associated with them. And we continue to encourage joint industry-academic cooperation which has made them possible.

Thank you.

[The prepared statement of Mr. Sloan follows:]

STATEMENT OF GEORGE SLOAN

TO THE HOUSE SUBCOMMITTEE ON SCIENCE, RESEARCH & TECHNOLOGY

FEBRUARY 8, 1988

ST. LOUIS, MISSOURI

Mr. Chairman, members of the Committee, thank you for inviting me to testify at this important hearing. I am George Sloan, Vice President of the St. Louis Regional Commerce and Growth Association. I also work part-time for the University of Missouri as the St. Louis Coordinator of the Missouri Research Park. Thus, my employment itself is a cooperative undertaking between business and the University.

I am particularly pleased to have an opportunity to make a statement with regard to business/university cooperation because this is an area where I have devoted most of my time and effort for the last six years. I also would like to point out that the St. Louis Regional Commerce and Growth Association itself is an excellent example of joint industry/academic effort. The RCGA has on its Board the heads of the principal universities in the St. Louis region, as well as representatives from all sectors of the St. Louis economy. In addition, the RCGA supports a Science and Engineering Committee, which includes among its members about forty distinguished representatives of business and academia. Mr. Chairman, I believe this Committee might well commend to the attention of other communities RCGA's unique blend of business and academic activity as a model for encouraging industry/academic cooperation in support of economic growth.

Now I would like to describe RCGA's program for promoting economic development through technological progress.

In 1982, the RCGA published a plan entitled, "A Hi-Tech Plan for St. Louis", which has as its goal the development of St. Louis as a major center for technological progress. This plan identified the characteristics of a community necessary for success as a hi-tech center; then measured St. Louis against these necessary characteristics, finding it well-endowed in all respects. The plan noted, however, that despite its advantages, St. Louis was not keeping pace with other communities in the technological parade. Specifically, although it is the home of a number of outstanding research universities and the location of several leading hi-tech corporations, St. Louis was not noted as the site of hi-tech start-ups. Nor had it served as a magnet for attracting research activities from other locations. The hi-tech plan sought to address these two deficiencies: first, by creating an Innovation Center - named St. Louis Technology Center - for the purpose of incubating hi-tech start-ups and second, by organizing a suburban university-based research park - named the Missouri Research Park - to attract hi-tech activities from outside the region. Both of these programs are now well on their way towards success - a success which has been made possible by strong financial support from the State of Missouri.

The St. Louis Technology Center, located in the old Falstaff building at 5050 Oakland Avenue, was organized in 1984 and opened its doors in 1985. From its beginning, it has been a joint university/industry activity. The first Chairman of the Board was Dr. William Danforth of Washington University. Other members of the Board represented St. Louis University, the University of Missouri, Southern Illinois University, and a number of St. Louis' leading hi-tech companies. The purpose of the Center is to assist emerging technology-based businesses. It does this by providing a home to these start-up businesses, thereby:

- Reducing operating costs;
- Easing administrative burdens;

- Offering experienced managerial support;
- Selling and licensing technologies;
- Conducting market research;
- Performing competitive analyses;
- Developing strategic plans;
- Obtaining financing;
- Supporting product development.

There are now twelve start-up businesses housed in the Center. Several other beginning enterprises located off-site are being assisted. To date, the Center has accomplished the following:

- An annual state investment of approximately $400,000 has leveraged $4,707,000 in private investments.
- Creating 108 jobs.
- Generating $2,517,000 in salaries.
- Resulting in a minimum of $181,000 annually in state and local taxes for the future.

This truly remarkable achievement has been made possible by the cooperative effort of business and academic leaders, as well as the energy and ability of its Managing Director, Mr. Gene Boesch, and his staff.

The Missouri Research Park is located on 700 acres of University of Missouri-owned land near Weldon Spring. The property is being developed through an appropriation of $4.5 million from the State of Missouri. The President of the University of Missouri has appointed a Board of Directors for the park consisting of the Chancellors of the four branches of the University of Missouri, the Chairman of the Board of Curators of the University of Missouri, the Chancellor of Washington University and several business leaders. This research park will provide a campus-like setting for research-oriented activities from both the public and private sectors. It will provide strong ties to both public and private universities for its tenants. The outstanding location, strong university connections and excellent support from the public and private sectors assure the success of this undertaking. Ultimately, it is expected to generate many thousands of jobs for the St. Louis region and the State of Missouri. As of today, first phase development of the infrastructure is nearing completion and ground will soon be broken for the first tenant.

Mr. Chairman, these are but two of several university/industry joint efforts which are contributing to the economic growth of this community. The RCGA is proud to be associated with them and will continue to encourage the joint industry/academic cooperation which made them possible.

Mr. **Walgren**. You will not really be 97 years old?

Mr. **Sloan**. Yes, I will.

Mr. **Walgren**. Well, I have to think about that.

Mr. Buechner?

Mr. **Buechner**. Dr. Jischke, you mentioned that process technologies, and it includes manufacturing, and some of our legislation that we have been working on various projects—and I know under Chairman Walgren's aegis——

Mr. **Walgren**. 87. [Laughter.]

Mr. **Buechner**. Anyway, we have been trying to put an emphasis on manufacturing. But do you think maybe manufacturing is too narrow, that process technology should be the thrust?

Dr. **Jischke**. Well, manufacturing is surely one aspect——

Mr. **Buechner**. Well——

Dr. **Jischke** [continuing]. And a major one. Manufacturing from Missouri is a very, very important component of our economy. There are 420,000 jobs there. It is 20 percent of Missouri's work force.

There are 7500 companies. If you do the division, it turns out the average company is about 50 people. These are small to medium-sized companies. Many of them are in the supplier business. They supply major assemblers.

Like the automotive industry we are second in the country in the assembly of cars. Like the aircraft industry, McDonnell Douglas.

And they are the people for whom I believe programs at universities can be particularly important. They are not at a scale where they can develop the technologies themselves—a company of 50 people cannot afford to go researching flexible manufacturing systems.

And yet it is absolutely pivotal that they gained access to that technology and employ it wisely. And the evidence heretofore in the United States is not particularly reassuring.

We do not use this new technology particularly well. The Japanese make something like 50 products per flexible manufacturing system. The United States averages less than 10.

So we do not use the technology well, and we typically take twice as long to implement it. And I believe there is a role for universities.

I would say manufacturing would be at the top. It certainly is not the only process technology, though. But it would be a major one.

Mr. **Buechner**. And also, to what extent do the programs you describe make use of the National technological—Technical Informational Service, Bureau of Standard; Automatic Manufacturing Research Facility, and inventions programs in the Federal Lab Consortium?

Dr. **Jischke**. We make use of those programs particularly in the transferring of technical information. The data bases we have gained access to really tap all of the government's resources.

The automated manufacturing demonstration facility, though, does not well serve the needs of small business. It is too far away.

I think one of the tricks in trying to bring this technology to smaller businesses is one must establish a network—a communications network that is done by people.

And people at the university in our Manufacturing Research and Training Center literally are going out and visiting with companies and trying to make clear to them our interest; the kinds of resources we have in working with them.

When you get as far away as Washington, a small company like Bronze Fabricators simply is—they do not know anybody there and they do not have the time to go.

And the universities—particularly these great land grant universities—I think it established a terrific record in the agricultural area and that suggests—some details aside—an extension model for other parts of the economy, particularly if you recognize that small businesses generate so many of these new jobs.

That is where we ought to be working to bring the resources of these research universities to bear.

Mr. **Buechner**. With that in mind, Dr. Mitchell is not here but, I know that the University of Missouri Agriculture School has been working on a number or projects which—if one were to use cotton, they would say "From dirt to shirt."

They are trying to find a way to integrate not only the cultivation but the processing of the product. And they are doing that with a number of what would probably be called almost primitive plants, but native rubber plants and various new types of plants that could be turned into the type of pulp that is usable for making paper.

And it is utilizing some of the new technologies, but trying to integrate not just the agricultural prospect, but also the aspect of bringing into it the processing and then ultimate manufacture.

Dr. Phillips, I have—this is my last question. You state in your prepared remarks that "ad hoc Congressional Bills for construction of buildings or laboratory facilities are to be deplored."

You wouldn't mean pork-barrelling by that, would you?

Dr. **William Phillips**. Well, sir, you can call it what you like.

Mr. **Buechner**. I am interested in knowing that since you have been in all elements of what we are talking about here that—how do you feel about dedicated facility programs?

Dr. **William Phillips**. Well, Congressman Buechner, I have some mixed feelings about this when it comes to dedicated facilities subtracting from the funding that will be available for individual investigators. As a mater of fact, I would—there is an excellent editorial—not editorial but a column in the New York Times today by Phil Anderson at Princeton, who had formally been at Bell Laboratories. On things like the super-collider, which I have no problems with, except to the extent that it does subtract from funding that would be available to the individual investigator.

Science—the best of science is a cottage industry in a sense. That is a highly competitive thing. This is why ours works so well, because of the competitive peer review system that we have.

And I am in favor of the big facilities, but frankly, not if this subtracts, and subtracts funding out from our individual investigators—which is our big pay-off in the United States.

Mr. **Buechner**. All right. Thank you.

Thank you, Mr. Chairman.

Mr. **Walgren**. Well, thank you, Mr. Buechner.

And the time has gone on that we should end. But I certainly want to express my appreciation to the witnesses on behalf of the Committee, and especially to Mr. Buechner for assembling the hearing and guiding and directing us towards each of you.

You have been good contributors to this record, and we appreciate having it. Thank you very much.

[Whereupon, at 1:48 p.m. the hearing was concluded.]

[The prepared statement of Dr. Schneiderman follows:]

Testimony before
U. S. House of Representatives
Committee on Sciences, Space and Technology
Subcommittee on Science, Research and Technology
Field Hearing on University/Industry Alliances
St. Louis, MO
February 8, 1988

Howard A. Schneiderman
Sr. VP, R&D
Monsanto Company
St. Louis, MO

Mr. Chairman:

I am Howard A. Schneiderman, Senior Vice President, Research and Development, at Monsanto Company which is headquartered in St. Louis, Missouri. It is a privilege to address the Subcommittee.

I should like to outline briefly my company's experience with university/industry research partnerships and why I believe they can be useful to companies, to universities and to the larger society.

Our nation's economy is rapidly changing from a resource-intensive economy to a knowledge-intensive economy. In agriculture, for example, the acres one could cultivate were once the dominant economic factor. Today, it is the knowledge-intensive methods used to manage those acres that determines the success of a farmer. Both agriculture and industry are learning how to substitute knowledge for resources. It is largely technological change, not access to natural resources that will drive America's and the world's economy in the future.

I am absolutely convinced that America can remain the leading productive economic force on this planet for the rest of this century and the next. But to secure this, this nation must be continuously positioned on the leading edge of technological change so that we can be the low-cost, high-quality producers of generation after generation of innovative and important products. For many industries in this country, the choice is clear: either be innovative or compete with a company in Japan, Korea, France, or elsewhere, which is innovative.

Many informed people believe that technological disadvantage has been a key factor in America's loss of economic competitiveness in industries like steel, automobiles, and much of electronics. Not the only factor, to be sure, but a key factor. There is reason to believe that unless we do something creative quickly this loss of competitiveness may damage other industries as well, such as pharmaceuticals, agriculture, telecommunications, and emerging industries such as those based on biotechnology, information science and new materials.

In my brief remarks I will suggest that one way to greatly enhance industrial competitiveness is to couple the talents of America's research-driven industries with those of America's research universities.

Each year this nation invests more than $6.5 billions of in university research. How can we use more effectively the knowledge base and the skill base created by our research universities to improve the economic competitiveness of the nation's research-driven businesses?

I will draw on the experience of Monsanto Company, but I believe that our experience can be relevant to other companies, both large and small, who are contemplating university/industry ventures. Although my viewpoint is that of someone who is presently in industry, you will have a chance later today to hear the views of some of Monsanto's university partners.

Last year, Monsanto spent about $625M on research and development, of which between 15 and 20 million was spent on university research collaboration. This amounts to about 3 percent of our total R&D budget.

Let me emphasize that I am not talking about philanthropic gifts to universities nor about clinical trials of drugs conducted in research hospitals or field tests of new herbicides conducted in land grant colleges. I am talking about genuine research partnerships aimed at discovery.

Monsanto's largest research partnership is with Washington University Medical School in St. Louis. Washington University scientists work together with Monsanto scientists to discover new facts of nature such as what causes abnormal heart beats, as well as to discover new biologically-active molecules such as a small protein produced by the human heart that regulates blood pressure.

This joint research is discovery research, the kind of research that is appropriate to universities. It is not drug development research, the kind of research that is done in industry and is not appropriate for universities. Monsanto's partnerships with universities are in the area of discovery, some times very long-term discovery. Nothing that we do with Washington University or with our other university partners encourages the universities to pursue to short-term utilitarian goals. We see the university as a great source of discovery, and we see our company as a full partner in discovery. We are able to bring new skills, new ideas, whole new technologies to the research programs we conduct together. Indeed, the money Monsanto provides to Washington University Medical School is far less significant than the scientific insights and skills that our scientists contribute to solving major problems of medicine.

Beyond this, Monsanto develops these discoveries into new products that benefit people, new products that preserve and create jobs for our employees and strengthen this nation's economy, new products whose commercial success encourages pension funds and individual investors to invest in us.

But be assured that everyone in Monsanto and everyone in Washington University Medical School involved in our joint program knows that the missions of research universities and of companies are different: the objective of a research university is to teach and to advance knowledge; the objectives of a company is to advance knowledge _and_ to use the knowledge gained to develop useful and profitable new products.

The joint discovery program between Monsanto and Washington University Medical School has had wonderful consequences for both institutions. Today hundreds of Monsanto scientists are part of a powerful team that includes about 120 Washington University scientists. Together we are able to solve some enormously difficult but important scientific problems that Monsanto can develop into new therapies for major diseases. We are convinced that our research collaboration with Washington University accelerates the rate at which our biomedical discoveries are translated or developed into new pharmaceutical products that benefit people. It is important to emphasize that the university is _not_ in the pharmaceutical business. It remains in the knowledge business. The actual conversion of our joint research into new drugs that help people, the actual _development_ of a new drug for hypertension, leukemia, osteoporosis, Alzheimer's disease or psoraiasis is done by Monsanto. Today five new therapeutic products based on the Washington University/Monsanto research are being developed by G. D. Searle, Monsanto's pharmaceutical subsidiary.

Since Monsanto began the program with Washington University in 1982, more than 50 patents have been granted or applied for, largely for new drugs based on our joint research. Who owns the patents on those new discoveries? Let's answer that question and a number of other questions which loomed large at the outset of our joint research ventures with universities but turned out to be of no practical consequence.

In the case of patents, the university owns the patents. Monsanto has the exclusive right to license any patents that may come from the research and we provide the support needed for the university to obtain patents. The university can expect conventional royalties from a patentable discovery when the product based on that discovery is commercialized.

Do we delay publication and prevent the diffusion of knowledge? We have asked for 30 days to review papers for patentability before publication. This has proven satisfactory for more than 100 papers, no delays, no problems, no being "scooped" by a competitor. Knowledge has been advanced and made available.

Do we "direct" the university's research. As a former dean, I can attest that no one tells a professor in an American university what to do.

What about the fear that a contract between a company and a university will encourage the university to pursue excessively utilitarian goals and to neglect the long-term fundamental questions upon which the advance of science depends? This simply hasn't happened in any of the more than 50 research projects Monsanto has underway with universities. Indeed, Monsanto support has often encouraged university scientists to attack extremely difficult problems of long-term duration which do not produce immediately publishable results and which were much less likely to be supported by a traditional federal grant mechanism.

What about the fear of the loss of confidentiality? When Monsanto shares private research information with an academic colleague, we expect him or her to keep the information private. When an academic colleague shares a private research result with us, we keep the information private. Our behavior in this regard is precisely what one would expect of research scientists in universities who share confidential information with each other.

What special advantages are there to the university from university/industry research collaborations? For the universities there are a variety of advantages. For example, industry places a higher premium on progress and results than on process and paper work. Industrial grants tend to be simpler to apply for and are often awarded in a month or two rather than the 9 plus months required for most government grants. Universities can gain important insights from companies into the relevance and applicability of a particular piece of research.

But the most important advantage to the university is partnership with an exciting group of industrial research scientists, with complementary skills, new viewpoints, fresh ideas, urgency and results orientation. Industrial partners can help university scientists win their races for discovery and advance knowledge.

For both universities and industry there are some common advantages. For example, research partnerships between university and industry can accelerate research in both institutions. Some important questions require large research groups and enormous outlays for equipment that are often far beyond the resources of a single laboratory or department and often exceed a given industrial or academic institution. A joint university-industry research program in plant molecular biology, with 60 scientists with diverse skills drawn from both the industrial and the university community, is far more likely to tease secrets from protoplasts, chloroplasts and plant chromosomes than are several mini-teams.

Also, research is increasingly expensive; big science is certainly not restricted to high energy physics. Institutional competitiveness has given way to regional competitiveness. University-industry partnerships not only enhance the research competitiveness of the individual scientists and the institutions involved, but may also enhance the technological and economic competitiveness of the regions in which they are embedded.

From more than 15 years of university/industry collaboration, we have identified three "musts" in making a university-industry partnership work. They are:

  - Identify a key individual with requisite authority as a company representative, key contact and problem-solver. This person must be dedicated to the success of the joint research venture.

  - Designate top company scientists for active collaboration with each university principal investigator.

  - Promote a spirit of give and take and openness among all participants. An academic scientist cannot hide behind the hedge of "academic freedom" to do entirely as he or she wishes. A debate with one side refusing to allow the possibility of having his or her mind changed is not a debate.

- Other factors crucial for success include:

  - Clear definitions of needs and expectations at the outset. We are talking about a collaboration, not a one-way efflux of money.

- Preserve academic freedom to publish and present papers and, at the same time, preserve industry's need to obtain patent coverage for important joint discoveries.

- Companies that wish to participate in joint ventures with universities must encourage their own scientists and engineers to publish. If this is an uncomfortable activity for a company, then don't enter a joint research program with a university.

- Industry must rapidly follow up research leads generated from the university if the relationship is to progress.

- There must be a willingness to have two-way free and open communication.

- In seeking university partners, do not rely solely on the "old guard". Seek ideas and proposals from younger scientists who are still in their "logarithmic growth phase".

- The ground rules between all parties must be clearly articulated and understood. There should be a social contract confirmed by a written contract.

- There should be a scientific oversight committee selected from the outside that reviews the work after a set period of time, assesses both its scientific merit and the impact of the program on the two institutions.

- Monsanto has had both very good and very bad experiences with university research programs. The bad examples occurred when there was little or no communication. Industrial funding was regarded as charity. There was no peer review, and as a consequence an adversarial relationship developed.

- Companies must not impose their "corporate culture and administrative controls" on their university programs. To be sure, it is comforting to do so, but universities are not corporate subsidiaries. Faculty partners are not employees. They are geese that lay golden eggs, and traditional corporate culture will sterilize them and stop the egg laying. Do not enter a partnership with a university unless you are prepared to leave your corporate management style behind.

Let me also add that:

- There is no "generic format" for university/industry partnerships. Each one must be hand crafted to fit the culture of the particular part of the company and the particular part of the university involved in the partnership. Partnerships between chemistry departments and companies will be different than between chemical engineering departments and companies. Partnerships between a university and a central research department in a company will be different from a partnership between that same university and an operating company or division with a profit and loss responsibility.

Lastly:

- Research partnerships with industry are not appropriate for some universities, for some departments, or for some individual scientists. But it can be a productive approach for some companies, for some universities and for some faculty members. Unless you are prepared to leave your suspicions behind, don't touch it. For such programs to work, both partners have to feel really good about it.

One of the issues upon which this Subcommittee has focused concerns foreign companies. Since university/industry partnerships can provide real economic advantage for the companies involved and for our nation, should government or universities seek to limit the involvement of foreign companies with university research? I believe that in most cases it would be a mistake to limit their involvement. Consider the following: Monanto Company's second largest partnership in university research is with Oxford University in the United Kingdom where we support a major research program on the chemistry and biology of the sugars that decorate many important proteins in the human body. Why Oxford University? Because it is the leading center in the world for that special kind of research. Access to Oxford University technology will accelerate rapidly Monanto's ability to introduce new drugs for presently untreatable diseases. It would be a great blow to both human medicine and to Monsanto if Monsanto scientists were prevented from collaborating with their British colleagues. It seems to me that fairness requires that if British companies like ICI or Glaxo decided to conduct joint research with a university in the United States, we should not hinder their programs.

In the case of Japan, it depends on whether American scientists can have ready access to the major research and engineering laboratories in Japan. Manufacturing technology is Japan's strong suit and one of the keys to Japan's economic competitiveness. If the Japanese will allow American engineers to collaborate with Japanese engineers in Japan at their great engineering research centers to design and improve manufacturing technology, and will allow American scientists and engineers to collaborate with their counterparts in Japan in designing new gene sequencers and other new instruments for biotechnology and will welcome American scientists into their world-famous ceramics research laboratories, then I have no problem with Japanese scientists and Japanese companies gaining access to America's strong suit, basic research and discovery. However, it should be a two-way street. More than 300 Japanese scientists conduct research at NIH in Bethesda, Maryland. I wonder how easy it is for American engineers to spend two years in manufacturing technology research centers and ceramic technology research centers in Japan.

Bottom line: I do not believe we should limit the involvement of foreign companies with American research universities. But we should insist on equal access for America's scientists, engineers and companies to the best research and engineering centers of other countries.

To conclude, if the United States is to remain the leading economic power in the world, it must consciously position itself on the leading edge of technological and industrial change. These technological changes are occurring in the pharmaceutical, agricultural, telecommunications and micro-electronics industries, production of new materials, industrial control systems and also in many of our mature manufacturing industries. I see opportunities for hybrid technological vigor and exciting intellectual advance as the result of thoughtfully selected joint research programs between industries and universities. It is a way to "rustproof" America. I see whole new industries and new job emerging. In my view, university-industry partnerships are a vital national necessity.

As a nation, we cannot hope to prosper in the long term as assemblers of imported parts and exporters of imported ideas. Let us not forget that one of America's greatest advantages is that we are a heterogeneous people with diverse heritages and diverse approaches to solving problems. That is precisely what invention and innovation require. There is no more fertile ground for invention and innovation than at the interface of America's great research universities and her industries. That interface can be a catalyst for increased economic competitiveness.

BIOGRAPHICAL SKETCH OF
HOWARD A. SCHNEIDERMAN

Howard A. Schneiderman is Senior Vice President, Research and Development, and Chief Scientist of the Monsanto Company, an Advisory Director to the Monsanto Board of Directors, and a member of the company's Executive Management Committee. He is a member of the Board of Directors of G. D. Searle & Co., a pharmaceutical company wholly owned by Monsanto Company.

In 1953, Dr. Schneiderman joined Cornell University as Assistant Professor, later becoming Associate Professor of Zoology. In 1961, he became Professor and Chairman of the Biology Department at Case Western Reserve University and Director of the Developmental Biology Center there. In 1966, he was named Jared Potter Kirtland Distinguished Professor of Biology at the University.

In 1969, he joined the faculty of the University of California, Irvine, as Professor of Biology and Chairman of the Department of Developmental and Cell Biology. Later he became Dean of the School of Biological Sciences and Director of the Center for Pathobiology there. At the University of California, Dr. Schneiderman conducted research in developmental biology and genetics, including growth control, congenital malformations and cancer.

He was named to his present position at Monsanto in 1979. He is Monsanto's representative to the Industrial Research Institute.

In 1975, Dr. Schneiderman was elected a member of the National Academy of Sciences and a Fellow of the American Academy of Arts and Sciences. In 1983, the University of Nebraska gave him the Gustavson Award. In that same year the Entomological Society of America gave him their Founder's Memorial Award.

Dr. Schneiderman is a member of the Board of Directors of the Institute of International Development and Education in Agriculture and Life Science. He is also a member of the Council of the Government-University-Industry Research Roundtable of the National Academy of Sciences. He is a member of the Boards of Trustees of the Missouri Botanical Garden and the International Society of Developmental Biologists.

He is also a member of the Board of Trustees of the Marine Biological Laboratory at Woods Hole, and the Woods Hole Oceanographic Institution, the Expert Committee for the Secretariat of the Organization for Economic Cooperation and Development, and many professional societies.

He is presently a member of the visiting committees of Harvard University and Carnegie Mellon University. He is an adjunct professor of Biochemistry and of Biology at Washington University in St. Louis. He also remains Professor on Leave at the University of California, Irvine, where he maintains an active professional interest in research in developmental biology.

Dr. Schneiderman has a Presidential appointment to the National Science Board. His term will expire in 1992.

Dr. Schneiderman has been a member of many editorial and advisory boards and continues to edit a series of textbooks in biology. He has authored more than 200 published research papers on various subjects including developmental biology and genetics, insect biochemistry and plant growth. More recently he has published various articles on industrial biotechnology and on university/industry interactions.

Born February 9, 1927, in New York, Dr. Schneiderman graduated from Swarthmore College in 1948 with a B.A. degree with high honors in mathematics and natural sciences. He earned an M.A. degree in zoology in 1949 and a Ph.D. degree in physiology in 1952, both from Harvard University. He received honorary D.Sc. degrees from La Salle College in 1975, from Swarthmore College in 1982, from the University of Toledo in 1984, and from the University of Massachusetts at Amherst in 1986.

He is married to the former Audrey MacLeod of Quincy, Mass., who is a writer. They have two children: a daughter who is a neurobiologist doing postdoctoral work, and a son who is a professional lutenist and classical guitarist.

~~November~~, 1988

APPENDIX

SIMPLIFIED AND STANDARDIZED MODEL AGREEMENTS FOR UNIVERSITY-INDUSTRY COOPERATIVE RESEARCH

GOVERNMENT-UNIVERSITY-
INDUSTRY RESEARCH
ROUNDTABLE

INDUSTRIAL
RESEARCH
INSTITUTE

National Academy Press Washington, D C 1988

The Government-University-Industry Research Roundtable

The Government-University-Industry Research Roundtable is sponsored by the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. The Research Roundtable was created in 1984 to provide a forum where scientists, engineers, administrators, and policymakers from government, university, and industry can come together on an ongoing basis to explore ways to improve the productivity of the nation's research enterprise. The object is to try to understand issues, to inject imaginative thought into the system, and to provide a setting for discussion and the seeking of common ground. The Roundtable does not make recommendations, nor offer specific advice. It does develop options and bring all interested parties together. The uniqueness of the Roundtable is in the breadth of its membership and in the continuity with which it can address issues.

The Industrial Research Institute

The Industrial Research Institute (I.R.I.) was founded in 1938 under the auspices of the National Research Council. Its purposes are to promote, through the cooperative efforts of its members, improved, economical, and effective techniques of organization, administration, and operation of industrial research, including means for more effective interaction with other corporate functions; to generate understanding and cooperation between the academic and industrial research communities; to afford a means for industry to cooperate effectively with government in matters related to research; to stimulate and develop an understanding of research as a force in economic, industrial, and social activities; to encourage high standards in the field of industrial research; and to promote communication and interaction with industrial research organizations in other countries. I.R.I. is an association of some 260 major industrial companies that provides a means for the coordinated study of problems confronting managers of industrial research and development.

Publications are available from:

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PREFACE

The simplified and standardized models of university-industry cooperative research agreements that are presented here are the products of a joint effort of the Government-University-Industry Research Roundtable and the Industrial Research Institute (I.R.I.). Our two organizations approached the task of developing these models with the goal to maximize productive research collaboration between industry and academia by streamlining the negotiation process for reaching a formal agreement. Some of the impacts we hope will result from use of the documents are: a decrease in the time and effort required to reach an agreement; partners in research programs, rather than developing a contract from scratch, will use much of the model and devote their energies to negotiating specific features; and companies and universities new to research alliances will have a sense of what is reasonable to consider in establishing a contract.

Two models are presented. For the purposes of basic research support, simple research grants between universities and companies, as illustrated in Part I, may be most effective. Where complex issues are raised by the parties, a research contract will be the most appropriate instrument. A "typical first approach" to such a contract is illustrated in Part II. These models are conceived as good examples of agreements, and good starting points for negotiations between the industrial sponsor and the university on a specific contract. They are not intended to serve as a final document. We recognize that modifications will be required as a function of the special characteristics of each collaborative research effort.

The preparation of these models was accomplished through a series of steps. The Roundtable, with the assistance of the I.R.I. Committee on University Relations, established an *ad hoc* committee of industrialists (Appendix II) to prepare initial drafts of the two agreements. The thought was to have industry, as the financial supporter of the research, take the lead for simplification. This concept is an outgrowth of the Roundtable initiative with the federal agencies to simplify the federal government-university research administration procedures. In that case, representatives from the federal agencies took the initiative for simplification[*] through the design and implementation of the Florida Demonstration Project.

The models drafted by this *ad hoc* committee were discussed at a workshop of university and industrial directors for sponsored research. Comments from that workshop have been incorporated into the document. The I.R.I. Committee on University Relations (Appendix III) then reviewed the models for their effectiveness and appropriateness as starting points for negotiations.

The Roundtable and the I.R.I. have worked together to ensure that the documents represent a reasonable approach to university-industry research agreements. Our efforts are based on the notion that research agreements should reflect the interests of both parties. We hope that both universities and industry will approach research undertakings with a degree of flexibility and creativity, taking into account the special interests and needs of each other.

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[*] For further information about the Florida Demonstration Project, please contact the Roundtable.

We expect that you will find these models useful as starting points for negotiations when setting up agreements. We would like to know how they worked, and would appreciate your responses to questions such as:

- Were the models an effective tool in the negotiation process?
- Did using the models save you time and effort in reaching an accord?
- What were areas that required negotiation? What were the resolutions?
- What areas did both parties agree to readily, but were different than presented in the models?
- What modifications in the models do you propose?

Your comments will be most helpful to us in considering future modifications of the models to reflect the most reasonable and effective starting point for negotiations for cooperative research agreements.

James D. Ebert
Chairman
Research Roundtable

S. Allen Heininger
President
Industrial Research Institute

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RESEARCH GRANT

(Date)

(Director/Administrator)
(Research and Development)
(University)
(Address)

Sir/Madam:

Re: Research Grant

(COMPANY) is pleased to provide an unrestricted grant of ________ Dollars ($________) to (UNIVERSITY) for the support of research in the field of ______________, conducted under the direction of Dr. _________. Our check payable to (UNIVERSITY) for the sum of the grant will be forwarded promptly under separate cover upon your indicated acceptance and return of a duplicate of this letter.

Although no accounting is expected in regard to this grant, regulations of the Internal Revenue Service may require that we produce your statement that the funds have been used for the stated purpose in order to receive appropriate tax recognition.

Please indicate your acceptance of this grant, and your certification that these funds will be used in support of the research indicated by signing and returning a duplicate of this letter for our files. The vehicle for transfer of funds should comply in all respects with the provisions of this letter.

Dr. __________ will serve as the technical contact for our company and will be responsible for following progress of the study, as well as assisting you as needed.

Very truly yours,

(COMPANY)
By: ______________________
Title: ______________________

ACCEPTED AND AGREED TO:

(UNIVERSITY)
By: ______________________________
Title: (Director/Designated Administrator for R&D)
Date: ______________________________

RESEARCH AGREEMENT*

THIS AGREEMENT effective this __ day of __________, 198_, by and between ______________ (hereinafter referred to as "Sponsor") and the UNIVERSITY OF ____________, a non-profit educational institution (or its agent) of the State of____________ (hereinafter referred to as "University").

WITNESSETH:

WHEREAS, the research program contemplated by this Agreement is of mutual interest and benefit to University and to Sponsor, will further the instructional and research objectives of University in a manner consistent with its status as a non-profit, tax-exempt, educational institution, and may derive benefits for both Sponsor and University through inventions, improvements, and/or discoveries;

NOW, THEREFORE, in consideration of the premises and mutual covenants herein contained, the parties hereto agree to the following:

Article 1 - Definitions

As used herein, the following terms shall have the following meanings:

1.1 "Project" shall mean the description of the project as described in Appendix A hereof, under the direction of Dr.__________ as principal investigator.

1.2 "Contract Period" is__________, 198_ through ________, 198_.

1.3 "University Intellectual Property" shall mean individually and collectively all inventions, improvements and/or discoveries which are conceived and/or made (i) by one or more employees of University, or (ii) jointly by one or more employees of University and by one or more employees of Sponsor in performance of Project.

Article 2 - Research Work

2.1 University shall commence the performance of Project promptly after the effective date of this Agreement, and shall use reasonable efforts to perform such Project substantially in accordance with the terms and conditions of this Agreement. Anything in this Agreement to the contrary notwithstanding, Sponsor and University may at any time amend Project by mutual written agreement.

2.2 In the event that the Principal Investigator becomes unable or unwilling to continue Project, and a mutually acceptable substitute is not available, University and/or Sponsor shall have the option to terminate said Project

---

*Brackets ([ ]) have been placed in the text where appropriate to indicate variable time frames that can be used in an agreement. In some cases, ranges of time have been placed in the brackets to suggest reasonable lengths of time.

Article 3 - Reports and Conferences

3.1 Written program reports shall be provided by University to Sponsor every [_______] months, and a final report shall be submitted by University within [forty-five (45) days] of the conclusion of the Contract Period, or early termination of this Agreement.

3.2 During the term of this Agreement, representatives of University will meet with representatives of Sponsor at times and places mutually agreed upon to discuss the progress and results, as well as ongoing plans, or changes therein, of Project to be performed hereunder.

Article 4 - Costs, Billings, and Other Support

4.1 It is agreed to and understood by the parties hereto that, subject to Article 2, total costs to Sponsor hereunder shall not exceed the sum of _________ Dollars ($_________). Payment shall be made by Sponsor according to the following schedule: [_________________________].

4.2 Sponsor shall loan/donate the following equipment to University under the following conditions: [_________________________________]. University shall retain title to any equipment purchased with funds provided by Sponsor under this Agreement.

4.3 Anything herein to the contrary notwithstanding, in the event of early termination of this Agreement by Sponsor pursuant to Article 9 hereof, Sponsor shall pay all costs accrued by University as of the date of termination, including non-cancellable obligations, which shall include all non-cancellable contracts and fellowships or postdoctoral associate appointments called for in Appendix A, incurred prior to the effective date of termination. After termination, any obligation of Sponsor for fellowships or postdoctoral associates shall end no later than the end of University's academic year following termination.

Article 5 - Publicity

5.1 Sponsor will not use the name of University, nor of any member of University's Project staff, in any publicity, advertising, or news release without the prior written approval of an authorized representative of University. University will not use the name of Sponsor, nor any employee of Sponsor, in any publicity without the prior written approval of Sponsor.

Article 6 - Publications

6.1 Sponsor recognizes that under University policy, the results of University Project must be publishable and agrees that Researchers engaged in Project shall be permitted to present at symposia, national, or regional professional meetings, and to publish in journals, theses or dissertations, or otherwise of their own choosing, methods and results of Project, provided, however, that Sponsor shall have been furnished copies of any proposed publication or presentation at least [_____] months in advance of the submission of such proposed publication or presentation to a journal, editor, or other third party. Sponsor shall have [______] months, after receipt of said copies, to object to such proposed presentation or proposed publication because there is patentable subject matter which needs protection. In the event that Sponsor makes such objection, said Researcher(s) shall refrain from making such publication or presentation for a maximum of [______] months from date of receipt of such objection in order for University to file patent application(s) with the United States Patent and Trademark Office and/or foreign patent office(s) directed to the patentable subject matter contained in the proposed publication or presentation.

Article 7 - Intellectual Property

7.1 All rights and title to University Intellectual Property under Project shall belong to University and shall be subject to the terms and conditions of this Agreement.

7.2 Rights to inventions, improvements and/or discoveries, whether patentable or copyrightable or not, relating to Project made solely by employees of Sponsor shall belong to Sponsor. Such inventions, improvements, and/or discoveries shall not be subject to the terms and conditions of this Agreement.

7.3 University will promptly notify Sponsor of any University Intellectual Property conceived and/or made during the Contract Period under Project. If Sponsor directs that a patent application or application for other intellectual property protection be filed, University shall promptly prepare, file, and prosecute such U.S. and foreign application in University's name. Sponsor shall bear all costs incurred in connection with such preparation, filing, prosecution, and maintenance of U.S. and foreign application(s) directed to said University Intellectual Property. Sponsor shall cooperate with University to assure that such application(s) will cover, to the best of Sponsor's knowledge, all items of commercial interest and importance. While University shall be responsible for making decisions regarding scope and content of application(s) to be filed and prosecution thereof, Sponsor shall be given an opportunity to review and provide input thereto. University shall keep Sponsor advised as to all developments with respect to such application(s) and shall promptly supply to Sponsor copies of all papers received and filed in connection with the prosecution thereof in sufficient time for Sponsor to comment thereon.

7.4 If Sponsor elects not to exercise its option or decides to discontinue the financial support of the prosecution or maintenance of the protection, University shall be free to file or continue prosecution or maintain any such application(s), and to maintain any protection issuing thereon in the U.S. and in any foreign country at University's sole expense.

Article 8 - Grant of Rights

8.1 Pursuant to Article 7.3, University grants Sponsor the first option, at Sponsor's sole selection, for either a non-exclusive, royalty-free license or, for consideration, an exclusive license with a right to sublicense on terms and conditions to be mutually agreed upon. The option shall extend for a time period of [____________] from the date of termination of the Agreement.

Article 9 - Term and Termination

9.1 This Agreement shall become effective upon the date first hereinabove written and shall continue in effect for the full duration of the Contract Period unless sooner terminated in accordance with the provisions of this Article. The parties hereto may, however, extend the term of this Agreement for additional periods as desired under mutually agreeable terms and conditions which the parties reduce to writing and sign. Either party may terminate this agreement upon ninety (90) days prior written notice to the other.

9.2 In the event that either party hereto shall commit any breach of or default in any of the terms or conditions of this Agreement, and also shall fail to remedy such default or breach within ninety (90) days after receipt of written notice thereof from the other party hereto, the party giving notice may, at its option and in addition to any other remedies which it may have at law or in equity, terminate this Agreement by sending notice of termination in writing to the other party to such effect, and such termination shall be effective as of the date of the receipt of such notice.

9.3 Subject to Article 8, termination of this Agreement by either party for any reason shall not affect the rights and obligations of the parties accrued prior to the effective date of termination of this Agreement. No termination of this Agreement, however effectuated, shall affect the Sponsor's rights and duties under Article 7 hereof, or release the parties hereto from their rights and obligations under Articles 4, 5, 6, 7, 8, and 10.

Article 10 - Independent Contractor

10.1 In the performance of all services hereunder:

10.1.1 University shall be deemed to be and shall be an independent contractor and, as such, University shall not be entitled to any benefits applicable to employees of Sponsor;

10.1.3 Neither party is authorized or empowered to act as agent for the other for any purpose and shall not on behalf of the other enter into any contract, warranty, or representation as to any matter. Neither shall be bound by the acts or conduct of the other.

Article 11 - Insurance

11.1 University warrants and represents that University has adequate liability insurance, such protection being applicable to officers, employees, and agents while acting within the scope of their employment by University, and University has no liability insurance policy as such that can extend protection to any other person.

11.2 Each party hereby assumes any and all risks of personal injury and property damage attributable to the negligent acts or omissions of that party and the officers, employees, and agents thereof.

Article 12 - Governing Law

12.1 This Agreement shall be governed and construed in accordance with the laws of the State of ____________________.

Article 13 - Assignment

13.1 This Agreement shall not be assigned by either party without the prior written consent of the parties hereto.

13.2 This Agreement is assignable to any division of Sponsor, any majority stockholder of Sponsor, and/or any subsidiary of Sponsor in which [____] percent of the outstanding stock is owned by Sponsor.

Article 14 - Agreement Modification

14.1 Any agreement to change the terms of this Agreement in any way shall be valid only if the change is made in writing and approved by mutual agreement of authorized representatives of the parties hereto.

Article 15 - Notices

15.1 Notices, invoices, communications, and payments hereunder shall be deemed made if given by registered or certified envelope, postage prepaid, and addressed to the party to receive such notice, invoice, or communication at the address given below, or such other address as may hereafter be designated by notice in writing:

If to Sponsor:
SPONSOR
ADDRESS
CITY, STATE, ZIP CODE

If to University:
UNIVERSITY
ADDRESS
CITY, STATE, ZIP CODE

If Technical Matter:
PRINCIPAL INVESTIGATOR
TITLE
UNIVERSITY ADDRESS
CITY, STATE, ZIP CODE

IN WITNESS WHEREOF, the parties have caused these presents to be executed in duplicate as of the day and year first above written.

(SPONSOR)	(UNIVERSITY)
______________________	______________________
By:	By:
Title:	Title:
______________________	______________________
Witness	Witness

APPENDIX I

OPTIONAL AND ALTERNATIVE CLAUSES

Appendix Article 1 - Non-disclosure

[Note: Since the term of the non-disclosure restriction is always longer than the term of the research project, it is much more efficient to have a separate non-disclosure agreement which can be administered long after the research is over and the file is closed. In the event, however, that a Non-disclosure Article is included in the Agreement, model language for such an article is provided. If a Non-disclosure Article is used, Article 6 - Publications should be replaced with the modified version below.]

1.1 Anything in this Agreement to the contrary notwithstanding, any and all knowledge, know-how, practices, process, or other information (hereinafter referred to as "Confidential Information") disclosed or submitted in writing or in other tangible form which is designated as Confidential Information to either party by the other shall be received and maintained by the receiving party in strict confidence and shall not be disclosed to any third party. Furthermore, neither party shall use said Confidential Information for any purpose other than those purposes specified in this Agreement. The parties may disclose Confidential Information requiring access thereto for the purposes of this Agreement provided, however, that prior to making any such disclosures each such employee shall be apprised of the duty and obligation to maintain Confidential Information in confidence and not to use such information for any purpose other than in accordance with the terms and conditions of this Agreement. Neither party will be held financially liable for any inadvertent disclosure, but each will agree to use its reasonable efforts not to disclose any agreed to Confidential Information.

1.2 Nothing contained herein will in any way restrict or impair either party's right to use, disclose, or otherwise deal with any Confidential Information which at the time of its receipt:

1.2.1 Is generally available in the public domain, or thereafter becomes available to the public through no act of the receiving party; or

1.2.2 Was independently known prior to receipt thereof, or made available to such receiving party as a matter of lawful right by a third party.

1.3 The above obligations for Confidential Information shall be in effect for a period of [five (5)] years from the termination of the agreement.

Modified version of **Article 6 - Publications**

6.1 Sponsor recognizes that under University policy, the results of University Project must be publishable and agrees that Researchers engaged in Project shall be permitted to present at symposia, national, or regional professional meetings and to publish in journals, theses or dissertations, or otherwise of their own choosing, methods and results of Project, provided, however, that Sponsor shall have been furnished copies of any proposed publication or presentation at least [______] months in advance of the submission of such proposed publication or presentation to a journal, editor, or other third party. Sponsor shall have [_______] months, after receipt of said copies, to object to such proposed presentation or proposed publication either because there is patentable subject matter which needs protection and/or there is Confidential Information of Sponsor contained in the proposed publication or presentation. In the event that Sponsor makes such objection, the parties shall negotiate an acceptable version, and the said Researcher(s) shall refrain from making such publication or presentation for a maximum of [______] months from date of receipt of such objection in order for University to file patent application(s) with the United States Patent and Trademark Office and/or foreign patent office(s) directed to the patentable subject matter contained in the proposed publication or presentation.]

Appendix Article 2 - Miscellaneous

2.1 The parties recognize that inventions, copyrightable works, or other proprietary information may arise from research sponsored in whole or in part by agencies of the federal government. The parties hereto agree that any such developments shall be governed by the provisions of Public Law 96-517, or as amended, during the term of this Agreement. When third party funding is involved, i.e., federal support, University will take appropriate action to assure that Sponsor has its rights under Article 8.

Optional Alternative Clause for **Article 7 - Intellectual Property**

7.1 University hereby agrees--to the degree that it can under university mandated policy--to assign to Sponsor at its request, the sole and exclusive ownership of any inventions, whether patentable or not, made in the performance of the research contemplated by this agreement and to execute such instruments prepared by Sponsor as is deemed necessary to vest the aforesaid sole and exclusive ownership. University agrees to cooperate in such assignment of patents for a period of [_______] following the request of Sponsor.

Optional Additional Clause for **Article 11 - Insurance**

11.3 Sponsor shall indemnify, defend, and hold harmless University against any and all claims, costs, or liabilities, including attorneys' fees and court costs at both trial and appellate levels, for any loss, damage, injury, or loss of life, other than that attributable in whole or part to University's fault or negligence, caused by the actions of Sponsor or its officers, servants, agents, or of third parties acting on behalf of or under authorization from Sponsor of products developed or made as a result of information or materials received from University, provided that (a) University promptly notifies Sponsor in writing after University receives notice of any claim, (b) Sponsor is given the opportunity, at its option, to participate and associate with University in control, defense, and trial of any claim and any related settlement negotiations, provided, however, that with respect to any claim, or portion thereof, from which Sponsor agrees at the initiation of such claim to save and hold University harmless, Sponsor shall have the sole control of the defense, trial, and any related settlement negotiations, and (c) University fully cooperates with Sponsor in the defense of any such claim.

APPENDIX II

AD HOC INDUSTRIAL COMMITTEE FOR SIMPLIFICATION AND STANDARDIZATION OF UNIVERSITY-INDUSTRY RESEARCH AGREEMENTS

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Vice President
CRG Technical Staff
Xerox Corporation

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Texaco Development Corporation

Preston Grounds
Manager, University-Industry
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APPENDIX III

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Research & Development
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Norman N. Hochgraft
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Exxon Chemical Company

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Corporate R&D
BASF Corporation

Dale F. Pollart
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Texaco Incorporated

Archie W. Prestayko
Vice President
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Craig B. Warren
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International Flavors and Fragrances, Inc.

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APPENDIX IV

WORKSHOP ON SIMPLIFICATION AND STANDARDIZATION OF UNIVERSITY-INDUSTRY RESEARCH AGREEMENTS

13 April 1987

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University of Florida

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Tom L. Tolbert
Director, External R&D
The Monsanto Company

Tom Walsh
Director of Sponsored Research
University of Florida

National Research and Development Policies for 1988 and Beyond: *The CORETECH Agenda*

CORETECH

COUNCIL ON RESEARCH AND TECHNOLOGY

CORETECH

COUNCIL ON RESEARCH AND TECHNOLOGY

Dear Colleague:

For the U.S. research community, 1988 will be a pivotal year. Policies advocated by Presidential candidates, and programs adopted by the 100th Congress, will shape the research and development climate for years to come. The 152 corporations, academic institutions, and their associations in the Council on Research and Technology have spent this past year deliberating how the critical process from the discovery of a new idea to its commercialization can be strengthened. "Research and Development Policies for 1988 and Beyond" grew out of these deliberations. **CORETECH** offers its recommendations to help guide political, business, and academic leaders in their quest for what can be done to keep us competitive in an increasingly interrelated global economy.

CORETECH's membership spans the U.S. research community including a broad spectrum of U.S. industrial sectors and research institutions. Its formation early in 1987 was a unique political alliance. Its policy agenda represents a unique consensus that industry, universities, institutes and government must work together to achieve good public policies on R&D just as they must work together in a day-to-day effort to achieve scientific and technological advances and their successful commercial application.

Six recommendations provide the framework for the CORETECH policy agenda, including:

I. Substantially increasing support for academic research.

II. Establishing a program to expand and improve the basic research infrastructure including university and research institute facilities, equipment, and instrumentation.

III. Strengthening incentives and support for industry research and development and removing disincentives to domestic siting of company R&D facilities.

IV. Encouraging cooperative research through programs and incentives.

V. Increasing financial support to ensure an adequate and well-trained supply of engineers and scientists.

VI. Improving, accelerating, and strengthening the commercialization of new and useful technologies.

CORETECH begins its second year with a sense of urgency. Our national R&D policies, to date, constitute a legacy of instability and unpredictability. The Research and Development Tax Credit was allowed to lapse in 1985 and, when renewed in 1986, it was cut back from an incremental rate of 25 percent to 20 percent. The moratorium on the Treasury Regulation Section 1.861.8, which is widely considered to be a serious disincentive to domestic siting of R&D facilities, was allowed to lapse in mid-1987. Federal funds for university research facilities fell 95 percent in real terms over the past two decades and National Science Foundation funding for university basic research has been essentially flat for many years when inflation is taken into account.

Therefore, CORETECH's policy recommendations reflect a philosophy of balance and continuity. We strongly advocate safeguarding and expanding our basic research base, and, at the same time, we urge that all actors in the R&D process emphasize technology transfer, commercialization, and advanced manufacturing technologies.

CORETECH

By their very nature, research and development and the commercial application of successful R&D are long term. Stable, supportive public policies are essential. **CORETECH** thus calls upon our national government to send a clear message to the U.S. research community that its work will be nurtured in a consistent manner. **CORETECH**'s action agenda for the near future reflects our concern with balance and continuity and calls for:

- A permanent Research and Development Tax Credit and a permanent Basic Research Credit.

- A permanent solution to longstanding problems with Treasury Regulation 1.861.8 which is a disincentive to domestic siting of R&D activities.

- A steady and substantial increase in research funding through the National Science Foundation.

- A public and private commitment to rebuilding our national research infrastructure through a new federal matching fund for restoring university research facilities.

- The continued tax exempt status of basic and applied research at universities and non-profit research institutes (and the continued taxable status of commercial product development at universities and other non-profit institutions).

CORETECH members are mindful that, as they embrace this policy agenda and work to achieve the action items, the strength of the U.S. research community is inextricably tied to the health of our economy as a whole. **CORETECH** fervently urges our leaders to quickly and effectively address the problems that threaten our future competitiveness.

In conclusion, we reflect that "Research and Development Policies for 1988 and Beyond" is not a quick fix approach. Rather, it reflects our serious commitment to the long haul. Moreover, we fully recognize that each of our recommendations, considered separately, would be woefully inadequate for the magnitude of the task. Taken together, we believe, these recommendations are a major step toward giving science and technology the direction and attention that will be needed if we are to remain a competitive nation for the remainder of this century and beyond.

We particularly want to thank all those who contributed their time to framing CORETECH's policy agenda. Internally, it reflects the efforts of CORETECH's Task Forces on Cooperative Research and Commercialization and our Research Policy Committee. Expert advice was given by both members and nonmembers at the four regional policy forums sponsored by CORETECH in October. We want to thank the Conference Board for cosponsoring those forums with us. We are grateful for the participation of so many who care about the U.S. research community.

Joseph A. Saloom

Dr. Joseph A. Saloom
Chairman; (Senior VP,
M/A COM, Inc.)

Ilene B Jacobs

Ilene Jacobs
Vice Chair; (Vice President &
Treasurer, Digital Equipment
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Stanley O. Ikenberry

Dr. Stanley Ikenberry
Vice Chair; (President,
University of Illinois)

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Robert M. Rosenzweig

Robert M. Rosenzweig
Co-Chair, Policy Committee;
(President, Assoc. of
American Universities)

Philip J. Robinson
Co-Chair, Policy Committee;
(Senior VP, Tektronix, Inc.)

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National Research and Development Policies for 1988 and Beyond

Introduction

> *...Technology is not a zero sum game; everyone can be a winner. As Alice said, 'All will be winners; all shall have a prize.'*
>
> *But Americans must take the game seriously, for there are other nations that do not consider it a game at all.* (Lewis M. Branscomb, Harvard University)

For the United States, the challenge of the late 20th century and beyond will be to remain the world's leader in science and technology and to realize commercial advantage in our advances. If we are to capture the rewards from today's breakthroughs in superconductivity, biotechnology, and other emerging technologies, then we must nurture, protect, and stimulate the process from discovery to commercialization.

The Council on Research and Technology, **CORETECH**, offers the following findings and recommendations in the hope that they will shed some light on the relationship between science and technology and competitiveness and what the national government, industry and academia can do to help keep us ahead in the global technology race.[1]

---

[1] "National Research and Development Policies for 1988 and Beyond" was adopted by the CORETECH Board of Directors at its December 9, 1987 meeting.

The Current Picture

> *Economists have long been preoccupied with policies that control the business cycle or improve static efficiency, but only a few focus on policies for growth. The institutional structure of the Federal Reserve Board has been the subject of exhaustive discourse. But the mechanisms for stimulating technological development have remained in the periphery of economic debate. That must be changed.* (Martin N. Baily, The Brookings Institution)

The federal government's roles and responsibilities in monetary and fiscal policies, as well as in international trade, are widely acknowledged. Less well established is what starts the engine of economic growth and what keeps it running in a keenly competitive world marketplace.

Now, as the Administration, the Congress and the Nation debate our international competitiveness, it is incumbent upon us, as a country, to explore fully what spurs productivity growth and hence, enables our future economic well-being.

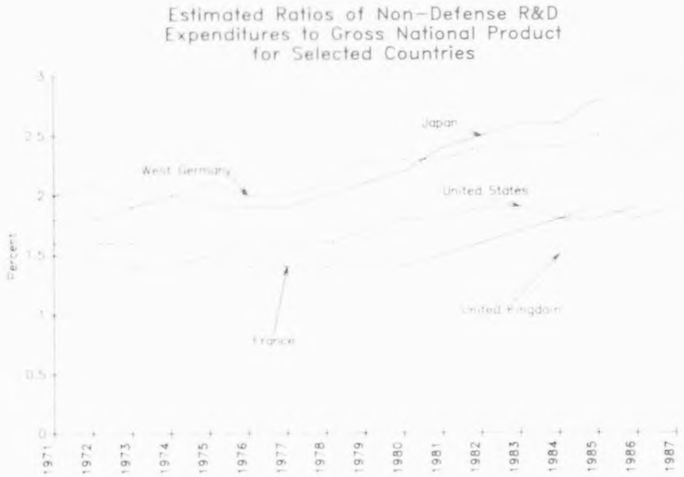
Leading economists now believe that the single biggest factor behind productivity growth is innovation and, they have demonstrated, two-thirds and possibly 80 percent of the productivity growth achieved since the Great Depression can be directly or indirectly attributed to innovation. In an industrialized society, research and development is the primary means by which technological innovation is generated.

However, because firms cannot capture fully the rewards from their innovations -- indeed the rate of return to society from innovation is estimated to be at least twice that which accrues to an individual company -- the market acting alone creates chronic, systematic underinvestment in R&D. This situation is further aggravated by the very high risk associated with R&D projects. Fully 80 percent of such projects are believed to be economic failures. Therefore, economists are nearly unanimous that the government should intervene to bolster research spending.

Private Research and Development

For most of the 1960s and 1970s, the government provided no special incentive for R&D, and private R&D spending in the United States was virtually stagnant. The United States trailed both Germany and Japan in the percentage of Gross National Product (GNP) spent on civilian research. (1.8 percent in the United States versus 2.4 percent in West Germany and Japan.) [See Figure 1.]

Figure 1



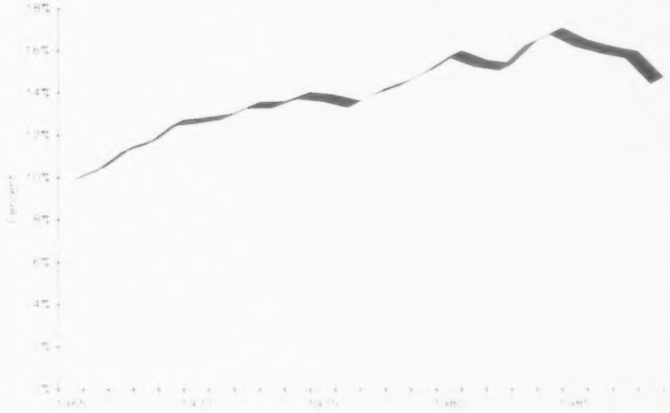
Since 1981, when the Research and Development Tax Credit was first adopted, there have been dramatic gains in private R&D spending. However, other countries also offer incentives for research and the United States continues to lag behind Japan and Germany in the proportion of GNP spent on private, civilian R&D.

Basic Research

The United States' commitment to basic research, the source of new industrial products and processes, has been increasing in recent years. However, despite annual increases in the total dollar amount spent in basic research, as a percentage of total Federal R&D, basic research spending has dropped in each of the past three years. [See Figure 2.] Federal support of university basic research has also declined as a proportion of federal R&D spending. Only about 20 percent of total federal civilian R&D funding is currently devoted to basic research in universities.

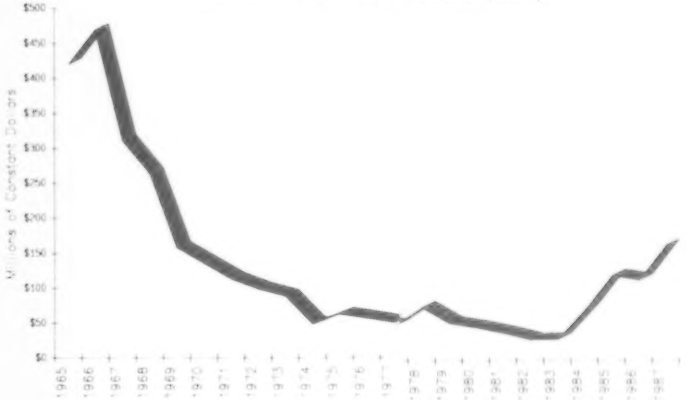
Figure 2

Basic Research as a Percent of
Total Federal R&D



University research facilities, where about half of all U.S. basic research is performed, are all too often antiquated and inadequate and the instrumentation and equipment used are frequently not state-of-the-art. Direct federal support of R&D physical plant in universities fell from $211.7 million (in 1972 constant dollars) in 1966, to $19.5 million in 1981. [See Figure 3.] In 1966, the percentage of NIH's research grants spent on instrumentation was 11.7 percent and for NSF, 11.2 percent. By 1982, these proportions were 4.5 percent and 9 percent for NIH and NSF, respectively. Although federal spending on instrumentation and equipment has been increasing, it still falls far short of need.

Figure 3



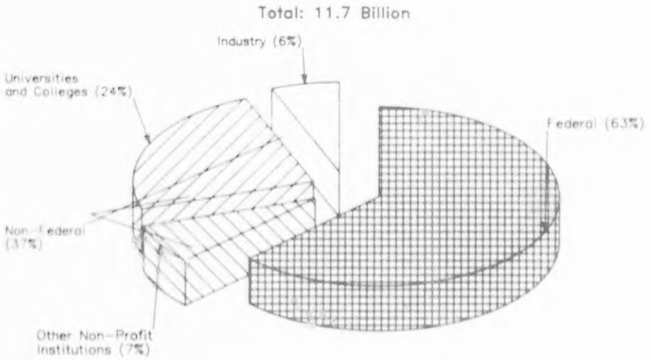
Federal Obligations for R&D Plant
to Universities and Colleges
Fiscal Years 1965–1988 (est.)

University-industry relations in research waned in the 1970s and industry funding of university research, 8 percent of all university research funds in 1960, declined to just 4 percent by the late 1970s. [See Figure 4.] Industry contributions for university basic research began to rise in the early 1980s. By 1986, industry funding constituted over 5 percent, or $375 million, of university basic research monies, three times the dollar amount spent in 1980. This upward trend, although encouraging, needs to continue if universities and companies are to begin to fully realize the advantages of working together. Chief among those advantages is the acceleration of technology transfer.

Compared to the funds spent by the federal government on basic research, little is spent or done to see that new research findings from research laboratories become new products or processes. As a result, the technology transfer process can take years or not happen at all. Technology transfer is important to competitiveness because "those who lead in translating new technologies into products and processes will reap the rewards in competitive advantage" (*Fortune*, October 13, 1986).

Figure 4

Academic R&D Expenditures by Source: FY 1988



Scientific and Engineering Manpower

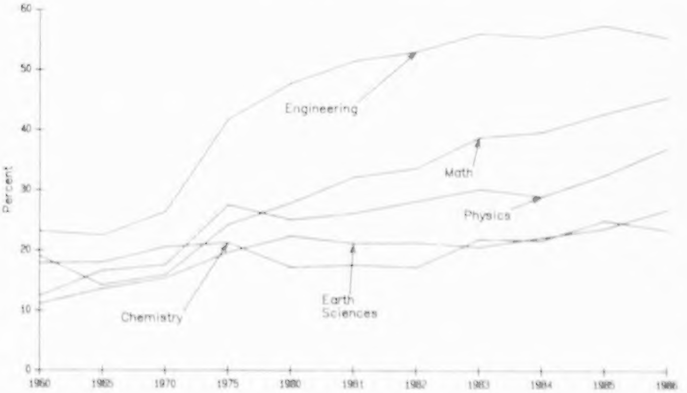
Twenty years ago, the United States led its competitors in the number of scientists and engineers relative to population. This is no longer true. Japan, for example, with half our population, has doubled its technical workforce over the past two decades and now produces more engineers than we do.

Moreover, the proportion of U.S. undergraduates majoring in the sciences and engineering has declined since the 1970s. At the graduate level, there has also been a proportional decline of U.S. citizens receiving advanced degrees in the critical fields of science and technology.

For example, more than half of the new PhDs in engineering in the United States are awarded to foreign nationals and overall, foreign students account for about 85 percent of the growth in graduate education in the United States. [See Figure 5.] This trend does not, it should be noted, reflect any great increase in the number of foreign graduate students, but rather a marked decrease in the number of U.S. students choosing to pursue graduate degrees.

Figure 5

Doctoral Degrees Awarded to Foreign Students
As a Percent of All Doctoral Degrees
From U.S. Universities



One result is that there are about 1,600 vacant engineering faculty positions at universities, and half have gone unfilled since 1984.

Because of the fact that the number of students in the appropriate age brackets for undergraduate school (18-22) will decline by one-quarter over the 1980-93 period, the number of science and engineering degrees will also decline unless a greater proportion of this group is attracted to these fields. Just to maintain current numbers, the attraction rate will have to increase substantially.

Commercialization

It is now clear that America's achievements in research have far surpassed our rate of success in the commercialization of technology. In field after field where U.S. scientists and engineers have pioneered, commercialization has lagged or not happened at all. For example, the videocassette recorder, invented in the United States, was successfully commercialized abroad.

The United States can ill afford to ignore the commercialization problem. Other countries aggressively pursue and strive to improve upon new technologies and emphasize the manufacturing process that allows production of new products at comparative advantage. American companies and institutions must do the same. Few American universities now offer degree programs in advanced manufacturing technologies and few U.S. industries give their assembly line engineers and managers the status their counterparts receive in other industrialized countries.

Summary Findings and Policy Recommendations

CORETECH's recommendations are directed primarily to the question: What is the appropriate role of the national government in encouraging research and development?

CORETECH therefore addresses the majority of its recommendations to the national government. **CORETECH** does, however, also strongly urge U.S. corporations, universities and research institutes working together cooperatively and acting alone to apply more of their own resources to research and development; to take the lead in finding commercial applications for new and useful technologies; and, to help make sure that our workforce is well trained and prepared for the future.

Findings

CORETECH recommends expanding the federal role in research and development for four major reasons:

1. The unprecedented internationalization of the market place is illustrated by the fact that fully 70 percent of our products must compete abroad in world markets or domestically against imports. Success in the international economy depends on science and technology, the "knowledge revolution," which in turn depends on our national investment in research and the highly skilled people to conduct it.

2. The nature of conducting research has been revolutionized and costs have dramatically increased. While great discoveries may still result from using simple paper and pencil, we cannot escape the fact that "we cannot do microelectronics without clean rooms with air 100,000 times as pure as normal rooms, and with floors virtually free from vibration; we cannot do chemistry and biology without special ventilation and waste disposal facilities; we cannot do large-scale computation without computer rooms with carefully controlled environments." (Dr. Roland Schmitt, Chairman, National Science Board).

3. Economists are in virtual unanimity that, without government intervention, the marketplace acting alone would fail to provide adequate spending for research and development activities. Chronic, systematic underinvestment in R&D is something that this country can simply not afford. We paid a high price for past complacency, and we now need to respond with a constructive agenda for action.

4. Only the national government can send a strong message to all of U.S. industry and academic institutions that scientific and technological advances are essential to the country's future and they will be encouraged by public policies.

Recommendations

Specifically, CORETECH recommends:

I. Substantially increasing support for academic research.

II. Establishing programs to expand and improve the research infrastructure including university and non-profit research institute facilities, equipment and instrumentation.

III. Strengthening incentives and support for industry research and removing disincentives to domestic siting of company R&D facilities.

IV. Encouraging cooperative research through programs and incentives.

V. Increasing financial support to ensure an adequate and well-trained supply of engineers and scientists.

VI. Improving, accelerating, and strengthening the commercialization of new and useful technologies.

Recommendation #1

The United States Should Substantially Increase Its Commitment to Research.

> *The power of American inventiveness -- from the light bulb to the laser, from the tractor to the transistor -- is legend. But now the rest of the world is determined to catch up. . . In the age of large-scale science, when research goals become national priorities and individual laboratory budgets can surpass the billion-dollar mark, the lone scientist still plays the central role in the process of inquiry that leads to breakthroughs.* (*Fortune*, October 13, 1986)

In order to safeguard and expand our essential research base, **CORETECH** recommends that:

o Corporations, whenever possible, should expand their commitment to basic and applied research.

o Universities should examine their own funding sources for research with the goal of maximizing own-source funding of research.

CORETECH supports a substantial expansion of the federal role in basic research and specifically recommends that the Congress:

o Double the National Science Foundation's budget by 1992 with emphasis on sustaining and expanding basic research activities and related education programs.

o Significantly increase the research budgets at the other major federal R&D departments and agencies, including: the biomedical and biotechnology research programs of the National Institutes of Health and the Alcohol, Drug Abuse, and Mental Health Administration; the Department of Defense's university research programs; the environmental, energy, and space sciences research programs of the

Environmental Protection Agency, the Department of Energy, NASA, and the National Oceanic and Atmospheric Administration; and the Department of Agriculture's university-based research programs

In addition, **CORETECH** strongly feels that present law exclusion for university and other nonprofit basic and applied research from taxation is critical to our competitiveness and should be continued.

Academic Research Support

CORETECH endorses the conclusion of the White House Science Council that: "We must make a greater commitment to our centers of learning in the 1980s than was provided to them in the 1970s, and the federal government must take the lead for the major fraction of that support."

For FY '88, **CORETECH** supported increasing NSF's appropriation by 17 percent, the Administration's requested amount, as an important step toward doubling the Agency's budget by the early 1990s.

For the past 20 years, in real terms, funding of NSF's basic research programs has remained essentially unchanged. **CORETECH** members feel strongly that this situation must change if we are to have the kind of scientific and technological breakthroughs necessary to keep us competitive in the years ahead.

Tax Exempt Status of University Research

CORETECH strongly supports the continued tax-exempt status of basic and applied research of universities and nonprofit research institutes. At a time when basic and applied research are a critical national need, the unrelated business income tax (UBIT) research exemption should not be restricted.

Research includes both the original investigation for the advancement of basic scientific knowledge and the application of this knowledge to create new ideas and processes; it does not include the commercialization of particular products. Although problems may arise occasionally in distinguishing between the two, the proper solution is not a radical change in the current tax treatment of university and nonprofit research institute research. Rather, the proper solution lies with carefully examining cited cases of improper characterizations to better administer existing law. Current law already provides for the taxation of the commercialization of a particular product by universities and other nonprofit research institutions and **CORETECH** strongly supports the enforcement of this provision.

CORETECH finds the proposed distinction between basic and applied research, as proposed by the minority members of the House Ways and Means Subcommittee on Oversight, to be troublesome. To begin taxing applied research by universities or other nonprofit research institutions, or even to increase uncertainties by subjecting applied research activities to a "substantially related test" would be detrimental for all concerned. **CORETECH** cautions that the term "applied research" is often misunderstood. It is properly defined as research which applies basic scientific principles to create new ideas and processes, but not the commercialization of specific products. As such, the benefits from applied research accrue not just to an individual or a single firm, but to society. "If the United States is now at a weak point in its competitive capabilities, a major cause is the small amount of currently conducted applied research," **CORETECH** told Congress in 1987. Tax policy should be encouraging university research, both basic and applied, not discouraging it.

Recommendation #2

The United States Should Substantially and Steadily Expand Its Investment in Academic Research Facilities, Equipment and Instrumentation.

> *The Nation's capacity to conduct high quality research and education programs and to maintain its competitive position at the forefront of modern science, engineering, and technology is threatened by '(a) research capital deficit, which poses serious and adverse consequences to our future national security health, welfare, and ability to compete in the international marketplace.* (H.R. 1905, The Research Facilities Revitalization Bill of 1987.)

CORETECH urges universities to:

- o Give priority to rebuilding, repairing or replacing their scientific and engineering research facilities.

CORETECH urges corporations to:

- o Make use of the enhanced deduction for equipment donations and the Basic Research Credit in order to help upgrade university research facilities and equipment.

CORETECH urges Congress to expand substantially funding for basic research infrastructure, including:

- o establishing new funds to help research institutions modernize and expand facilities and equipment;
- o creating a special research facility category that would remove the $150 million limit on tax-exempt financing by private universities;
- o providing for realistic depreciation periods for federal reimbursement purposes; and
- o enhancing equipment donation provisions.

Research Facilities, Equipment, and Instrumentation

CORETECH urges that the federal government help universities restore their research facilities and equipment over the next decade. It has been estimated that the total federal and non-federal cost of this undertaking will be about $10 billion.

Specifically, **CORETECH** strongly supports H.R. 1905, "The University Research Facilities Revitalization Act of 1987," as an important first step toward providing adequate research facilities, instrumentation and equipment to meet the nation's basic research needs.

CORETECH further recommends establishing comparable facilities modernization funds at the other major R&D federal departments and agencies.

CORETECH also recommends that nonprofit research institutes not affiliated with universities but where research and research training are conducted should be eligible applicants for the proposed NSF and other federal research infrastructure grants.

Tax-Exempt Financing

Because tax exempt financing is an important funding source for university research facilities, **CORETECH** urges Congress to create a research facility exemption to the $150 million limit on tax-exempt financing by private, non-profit institutions. Such a research exemption will permit the nation's private university and college research programs to raise funds for research facilities.

Indirect Costs of Research

CORETECH also urges the federal government to use realistic, useful life-times when determining indirect costs of doing research. Specifically, the OMB circulars governing the treatment of these costs at universities and independent research institutes (OMB Circulars A21 and A-122, respectively) should reflect that a more realistic measure of the useful life of university buildings is closer to 20 years, compared to the current assumption of 50 years. Similarly, the useful life of equipment and instrumentation should be considered as 5-10 years, depending on the class of equipment, compared to the present level of 15 years. These "use allowances" are also endorsed by the White House Science Council as realistic and useful.

Enhanced Equipment Donation Provision

CORETECH finds that the enhanced deduction for equipment donations from companies to universities and other qualified institutions for scientific research has been a significant source of state-of-the-art equipment and instrumentation for these laboratories. For example, computer manufacturers donated $74 million worth of products to educational institutions in 1985 according to the Council for Financial Aid to Education. Present law provides the enhanced deduction for donations of inventoried scientific equipment and apparatus to universities and nonprofit research institutes for use in research or research training in the physical and biological sciences. **CORETECH** supports modifications to the enhanced deduction (Section 170 of the Code) to increase its effectiveness while avoiding significant revenue costs, including:

o permitting donated equipment to be used for education as well as for research and research training;

o permitting software donations to be eligible for the enhanced deduction; and,

o several technical amendments.

Recommendation #3

The United States Should Provide Adequate Incentives and Support for Industrial Research and Development and Remove Disincentives to Domestic R&D.

> *It is good economics, as well as good public policy, to provide substantial public subsidy for research and development.* (Herbert A. Simon, Nobel Prize in Economics, 1978)
>
> *If the United States is going to prosper at home and compete abroad it needs all the R&D investment it can get.* (John Chancellor, NBC News)

CORETECH recognizes that industrial research and development is primarily a private activity. **CORETECH** therefore recommends that U.S. industry:

- Make every effort to expand their own investment in research and development and place R&D needs high on their corporate priority lists.

CORETECH also finds that, although industrial R&D is and should be primarily private and market-driven, the federal government nonetheless has an important role to play and should act to:

- Strengthen the R&D tax credit and make it permanent.
- Remove statutory and regulatory disincentives to R&D, beginning with Treasury Regulation 1.861.8.

The R&D Tax Credit

To correct structural underinvestment in R&D and to spur innovation, Congress should restore the R&D tax credit to its original 25 percent incremental rate and make it a permanent part of the U.S. Tax Code.

The R&D tax credit is the single provision in the Code designed to increase applied industrial research. It was first adopted in 1981 as part of the Economic Recovery Tax Act and was in effect during a period of dramatic gains in private R&D spending, from $30.9 billion in 1980 to almost $60 billion in 1986.

The original R&D tax credit expired on December 31, 1985. During 1986, the year its extension under tax reform was debated, R&D spending increased but at a significantly lower rate than the previous year, 9 percent as compared to a 12 percent rise in 1985. R&D projects are multiyear projects that are associated with considerable risk for individual companies. **CORETECH** therefore urges Congress to make the R&D tax credit a permanent, stable part of the Code. Most economists who have studied the credit agree that it should be made permanent.

A study conducted by Drs. Martin Baily and Robert Lawrence, both of the Brookings Institution, showed that a permanent R&D tax credit would more than pay for itself. Using standard economic assumptions (and a 25 percent rate for the credit), they estimated that a permanent credit could boost GNP by as much as $17 billion annually beginning in 1991.

Because of the R&D tax credit's unique incremental nature, it is important that Congress restore it to its original 25 percent incremental rate. The credit can be claimed only for increases in company R&D spending that are above the company's average R&D spending for the prior three-year period. The true effective value of the credit was therefore only 7 percent when it was set at the 25 percent rate. Following last year's reduction to a 20 percent incremental rate, the credit's real incentive value is now on the order of 4.5-5 percent.

A number of proposals have been put forward to alter the structure of the R&D tax credit. Several significant changes were already made such as tightening the definition of eligible R&D under the 1986 extension, but a number of other important issues were raised and not fully resolved. For example, the extension of the R&D tax credit to startup ventures was proposed but not included under tax reform.

CORETECH endorses extending the credit to startup companies. **CORETECH** has carefully studied the possibility of making additional changes to the current structure of the R&D tax credit. It will be consulting with its Congressional sponsors and the Treasury Department to determine if such changes are practical in the current political environment.

Section 1.861.8

The inclusion of Section 1.861.8 in the Treasury Department regulations is a disincentive to domestic research and development because it requires U.S. companies with foreign operations to allocate a portion of their domestic R&D expenditures to income earned abroad. The net effect is to disallow a full deduction for domestic R&D expenditures.

CORETECH therefore urges Congress and the Administration to put in place a permanent and fair alternative to Section 1.861.8. Congress has recognized the potentially harmful effects of this regulation and has passed temporary moratoria on its implementation. The last moratorium expired in August, 1987. Thus, **CORETECH** urges Congress to act swiftly to prevent movement of R&D abroad where similar disincentives do not exist, but where significant incentives are in effect to encourage R&D.

Recommendation #4

The United States Should Actively Encourage Cooperative Research.

> *If we are to have an acceptable future in an increasingly technological and competitive world, and if we are to respond adequately to national needs in areas of economic competitiveness, national security, and quality of life for all our citizens, the time has come when a new partnership involving all three, the federal government, universities and the private sector, must be forged.* (Report of the White House Science Council, February 1986)

Cooperative research between various combinations of corporations, universities, research institutes and the government is important to achieving technology transfer and economic efficiency. **CORETECH** therefore believes that the public and private sectors should act to strengthen cooperative research.

Specifically, **CORETECH** calls on industry and academic research institutions to:

- Make every effort to initiate or expand their cooperative research ventures.
- Examine their own cultural or institutional barriers to fuller participation in cooperative research relationships.

CORETECH further recommends that the federal government take a number of steps to facilitate and encourage cooperative research:

- Explore additional multidisciplinary, cooperative approaches to research projects.
- Provide seed grants on a matching basis for technology partnerships, that is, cooperative research projects between any combination of companies, universities, research

institutes, and government laboratories which appear likely to lead to commercialization of useful technologies.

- Establish a federal pilot program to demonstrate a "Small Business" University Research Program to allow academic researchers to begin to explore the commercial applications of their work.

- Institute new Presidential awards for outstanding academic-industry joint research.

- Make the Basic Research Credit permanent.

- Make cooperative research eligible for the Basic Research Credit.

The Basic Research Credit

CORETECH commends the Congress for adopting the new Basic Research Credit under the 1986 Tax Reform Act to encourage company support of basic research at universities and other qualified research institutions. **CORETECH** urges Congress to make this Basic Research Credit a permanent part of the Tax Code. A permanent credit is more likely to encourage stable funding of multiyear projects. The Basic Research Credit is currently scheduled to expire on December 31, 1988. A two-year time period is simply too short to determine the credit's effectiveness in stimulating company support of basic research, which is, by its very nature, long-term and high-risk.

CORETECH also believes that all types of cooperative basic research should be eligible for the Basic Research Credit. Because of their key role in technology transfer, for example, consortia of companies to do basic research are potentially of great benefit to society. Contributions to these consortia should be applicable to the Basic Research Credit.

Multidisciplinary Research Centers

CORETECH supports the National Science Foundation's initiative to fund more joint multidisciplinary research centers. **CORETECH** agrees with the view of the White House Science Council that we must promote a broad interdisciplinary approach to research that will "improve cooperative linkages between scientists, engineers, and industry." **CORETECH** notes that a multidisciplinary approach to enhance problem solving capabilities is being followed by NSF in its Engineering Research Centers, and by the Department of Defense through its University Research Initiative, and by NASA which funds multidisciplinary centers for the commercialization of space.

At the same time, **CORETECH** recognizes that the strength of multidisciplinary research depends upon the vitality of the individual disciplines brought together. Multidisciplinary and traditional, department-based research should be viewed as fundamental and supportive activities. **CORETECH** therefore supports expanding federal support of multidisciplinary research but notes:

> *Any revision of the culture and structure of what has been a very successful research environment ought to proceed cautiously and should not jeopardize the competitive individual investigator system which has served us so well. Individual autonomy and pluralism - often cited as the foundation of the innovative capacity of U.S. science - may be undermined by moving the individual investigator to a secondary role.* (Harold T. Shapiro, *Issues in Science & Technology*)

CORETECH is particularly concerned that any increase in funding of multidisciplinary endeavors be on a stable and predictable basis and that it not be at the expense of individual basic research funding. Indeed, as the previous sections outlined, **CORETECH** strongly supports and urges increased funding for traditional basic research and basic research facilities and equipment.

Program Development and Implementation

CORETECH believes that there is a need for additional government support of cooperative research undertakings, particularly as they relate to commercialization. Two new types of assistance are therefore recommended: "seed" grants for cooperative research with commercialization potential and a

Small Business University Research Program. These two new thrusts will be developed further by **CORETECH** as discussed under Recommendation No. 6 of this Agenda.

Academic/Industry Joint Research Awards

CORETECH supports instituting a new Presidential award for outstanding academic-industry joint research in the belief that such recognition will bring attention to innovative programs and encourage others in industry and academic research to consider joint research undertakings.

Recommendation #5

The United States Should Help Assure an Adequate Supply of Well-Trained Scientists, Engineers and Technical Personnel.

> *The skill, dexterity and knowledge of a nation's people is the most powerful engine of its economic growth.* (Adam Smith)

CORETECH urges universities and other academic institutions to:

- Closely examine the allocation of their own resources to determine how to increase the number of students, particularly women and minority students, choosing to enter scientific and technical fields.

CORETECH urges corporations to:

- Initiate (or expand) their financial and training programs for students in scientific and technical fields. To the extent possible, companies, cooperative research ventures, and independent research institutes, should offer work/study programs to acquaint students at undergraduate and graduate levels with state-of-the-art equipment and instrumentation and ongoing corporate research and development activities.

CORETECH strongly recommends that the federal government should:

- Pay close attention to and provide support for the training of American students in mathematics, science, engineering, and computer sciences and to insure an adequate supply of university faculty members in these disciplines.
- Significantly increase the number of graduate fellowships in mathematics, science, engineering and computer science, and take special steps to encourage women and minorities to enter these fields.

o Reconsider the effect of the 1986 Tax Reform Act on students and how it will affect research and development.

Graduate Fellowships

CORETECH endorses significantly increasing the number of graduate fellowships in scientific and technological fields awarded by such federal agencies as the National Science Foundation, the National Institutes of Health, the Department of Defense, and others. Specifically, **CORETECH** endorses NSF's proposal to award an additional 200 graduate fellowships. At the same time, **CORETECH** supports providing adequate federal financial support for able undergraduate students in mathematics, computer sciences, engineering and the biological and other natural sciences.

Mathematics, Science, Engineering and Computer Science Education

CORETECH recognizes the importance of improving mathematics, science, engineering and computer science training at all levels of our educational system. Specifically, **CORETECH** recommends:

o Reauthorizing the Education for Economic Security Act, which expires at the end of FY 87, with emphasis on improving the training of American students in mathematics, sciences, computer science, and engineering from elementary school through their undergraduate education; women and minorities are currently underrepresented in these fields and their participation should be encouraged under federal programs;

o Emphasizing foreign language training to facilitate U.S. knowledge of foreign technology and scientific advances and exchanges;

o Strengthening programs such as the Presidential Young Investigator Awards which help attract science and engineering faculty.

Taxation of Student Aid

The Tax Reform Act of 1986 included various forms of student assistance in gross income, except that portion spent for tuition and equipment. CORETECH urges Congress to reconsider the impact of the Tax Reform Act on students, and to examine how the taxation of fellowships, scholarships, and other forms of student assistance (including tuition remission) is affecting research and development.

Recommendation #6

The United States Should Act to Improve and Accelerate the Commercialization of New and Useful Technologies.

> *Technology is the wild card of the future.... Recognizing this unbreakable link between technology and economic competitiveness, industries and nation today are caught up in a desperate race to create, apply, and protect new technologies. If the United States is to maintain competitiveness and jobs, it has no choice but to strengthen its scientific base and improve its capacity to commercialize.* (Pat Choate, *The High-Flex Society*)

CORETECH's recommendations to improve our capacity to commercialize technologies fall into two broad categories, including:

o Accelerating and strengthening the technology transfer process, including the acquisition of and improvement upon technology from abroad.

o Providing specific incentives and programs to encourage commercialization.

In addition, CORETECH stresses the importance of cooperative research (see Recommendation #4 of the agenda) to achieving technology transfer, economic efficiency, and therefore, commercialization.

Further, CORETECH's research policy committee will develop specific legislative proposals in the area of commercialization.

Major Factors Affecting Commercialization

Three major factors form the basis for CORETECH's policy recommendations on commercialization as follows:

The Essential Research Base. CORETECH notes that at the same time that we, as a nation, must emphasize commercial application, we must safeguard and increase our investment in industrial, academic, and government research. A healthy research base is critical to ensuring future advances that will, in turn, lead to tomorrow's new products and processes.

It was no accident that the Post World War II period of phenomenal growth coincided with massive investments in science and technology that began in the early 1940s and accelerated after the Sputnik challenge of the late 1950s. However, for the past 20 years, the National Science Foundation's spending in real terms on basic research has been flat; federal support for university research facilities and equipment has plummeted; and, industrial R&D has lagged behind our major competitors when measured against Gross National Product. CORETECH strongly reiterates its call to reverse these trends.

Private Industry Initiative. CORETECH further emphasizes that U.S. companies bear the primary responsibility for bringing new products to market and for advancing and implementing manufacturing technologies. If we are to meet the commercialization challenge, American industry must be aggressive in seeking out new ideas and more determined in seeing that they become commercially-viable. American universities, for their part, must engage in a wider dialogue, including greater personal interaction, with industry to increase their awareness of corporate technology needs and of the commercial potential of their laboratory findings.

As in other policy areas, CORETECH addresses the majority of its recommendations on commercialization to the public sector because the federal government does have a critical support role in facilitating private initiatives. It is CORETECH's view that government must make a meaningful commitment to supporting the commercialization of new and useful technologies and that without such a commitment, our competitiveness will be in jeopardy. Overall, meeting the commercialization challenge will require the cooperation of all affected sectors: labor, academia, and government as well as business.

The Broader Context. Finally, CORETECH recognizes that there are many factors which directly and indirectly affect the commercialization process. Even if all of CORETECH's recommendations are implemented, they will not ensure successful commercialization unless there is a healthy economy including available capital and healthy markets. Knowledgeable observers have also pointed to our preoccupation with short-term profitability, our trade and budgetary deficits, our low rates of saving and investing, and our society's litigiousness as influences on the commercialization process. Although these factors lie outside the scope of the CORETECH agenda, CORETECH members recognize their importance and feel that these issues must be addressed by policymakers in government and leaders in the private sector.

Given these findings and general directions, the following recommendations are offered by CORETECH to improve and accelerate commercialization:

Recommendations on Commercialization

Technology Transfer

The commercialization process depends on the effective two-way communication of research findings and technological needs between scientists and engineers involved in research, on the one hand, and those involved in product development, manufacturing, and marketing, on the other. Until very recently, however, little attention was paid to how technology transfer occurred. Few models currently exist to demonstrate how it can be accomplished successfully. Further, and very importantly, there has been precious little effort expended to learn about, apply, and improve upon technology and manufacturing processes from abroad.

To improve and accelerate the technology transfer process, CORETECH strongly urges corporations, universities, and research institutes to:

o Examine the ways in which their own researchers, administrators, managers and officers communicate research findings and technology needs. If not already in place, companies and academic research institutions should establish procedures for (l) identifying commercial technology needs to those within company R&D divisions or within academic research institutions; and (2) communicating new research findings to other divisions within each company and university and to other sectors of the research community.

- o Establish (or expand) their own personnel exchange programs to encourage the interchange of scientists, engineers, and R&D managers among industry, academia, and government laboratories. These exchanges will encourage person-to person relationships that many feel are the key to successful technology transfer.

- o Actively monitor and aggressively seek to apply and improve upon scientific, technological and manufacturing advances from other countries.

To facilitate technology transfer within the private sector and between government laboratories, companies, and academic institutions, **CORETECH** recommends that the federal government:

- o Provide federal tax incentives to encourage companies to enter into personnel exchanges of scientists, engineers, R&D managers and officers with academic institutions and government laboratories.

- o Expand federal fellowship programs to encourage exchanges of scientists, engineers, and research administrators between corporations, academic institutions, and government laboratories.

- o Establish a federally-funded program to develop and test creative models of technology transfer. These models should analyze the respective advantages of and interaction between "market pull" and "technology push" technology transfer. In the former, user needs and wants are identified and efforts are made to satisfy these through technologically-innovative products and processes. In the latter, research findings are disseminated in the expectation that new product and process development will ensue.

- Ensure that the findings of non-classified research from federally-funded research and from federal laboratories remain freely accessible.

- Establish mechanisms to ensure that information about ongoing research in federal laboratories is known in relevant industries and academic institutions.

- Fully implement the Technology Transfer Act of 1986 to effectively transfer technology from government laboratories to industry. Congress should monitor implementation of this Act closely to determine what, if any, impediments remain to industry access to the non-classified work of government laboratories.

- Ensure that federal policies do not inhibit the traditional role of nonprofit, tax-exempt research institutions in the technology transfer process.

- **CORETECH** recommends that the U.S. Departments of Commerce and State intensify their efforts to identify relevant and useful information about technological and scientific developments in key industrialized countries for use by American companies and academic institutions..

- Form an advisory group from industry and academia to advise the U.S. Departments of Commerce and State on the acquisition of scientific and technical information from abroad. This group should pay particular attention to the programs that provide translations of Japanese and other foreign scientific and technical literature to ensure that they are directed to areas of greatest need.

- Include international technology flows as part of U.S. trade negotiations. A report prepared for the President's Commission on Industrial Competitiveness concluded that "a glaring asymmetry" characterizes the international flow of technological knowledge and that the flow has been preponderantly "out from the U.S." **CORETECH** therefore urges U.S. trade negotiators to make the equitable flow of technology a priority negotiating item.

Commercialization Programs and Incentives

Because of the high national stake in the commercialization of emerging and useful technologies, companies, academic institutions, and the government should make a concerted effort to raise its visibility and encourage its improvement.

Toward that goal, **CORETECH** calls on companies and universities to give manufacturing technologies a higher priority. Specifically, **CORETECH** urges that:

- Academic institutions establish new or expand ongoing degree programs in advanced manufacturing technologies.
- Corporations should actively support these programs by being involved both in their development and implementation and on a continuing basis through training and internship programs.

CORETECH recommends that the federal government assume a more active role in facilitating private sector initiatives to bring new products to market and advance new processes. The federal government should take the following steps:

- Alter the Small Business Innovative Research (SBIR) program to (l) provide a part of agency funds for unsolicited proposals; and (2) provide funding to bridge the transition between the Phase I start-up period and the Phase II implementation period of the SBIR program.
- Establish a federal demonstration program for developing and testing new commercialization models, including advanced, flexible manufacturing centers, for companies, universities and state support programs.
- Encourage the development of degree programs in advanced manufacturing technologies by establishing a new federal fellowship program for pre and post-doctoral students in that field.

- Encourage commercialization of research conducted under federal sponsorship by allowing all performers of such R&D ownership of intellectual property developed thereunder.

- Expand the current R&D tax credit to allow companies to claim R&D expenditures made to develop and improve manufacturing processes (including assembly processes) that are related to the manufacture of a new or improved products.

- Make the R&D tax credit permanent.

Future Agenda Items

CORETECH members recognize that a number of its recommendations require greater specificity for consideration in the legislative process. **CORETECH**'s Research Policy Committee will further discuss and develop new proposals for federal programs to:

1. Model and test creative methods of technology transfer.

2. Develop and test new commercialization models, including advanced, flexible manufacturing centers, for companies, universities and state support programs.

3. Provide seed grants for technology partnerships.

4. Assist states and communities in spurring the commercial application of useful technologies.

In addition, the **CORETECH** Research Policy Committee will look into federal antitrust laws as they apply to cooperative research ventures, including "generic" joint manufacturing, and as they influence competitiveness in a global economy. **CORETECH** will try to determine if there is a need for change in antitrust law and, if so, what direction that change should take.

Finally, **CORETECH** members believe that American intellectual property is a valuable national resource, and we must work actively to strengthen its protection among our trading allies. We need to assure effective protection to increase America's competitiveness in international markets, and to maintain incentives for American innovative efforts through research and development. Therefore, **CORETECH**'s Research Policy Committee will also be looking into the intellectual property system as it protects U.S. intellectual property rights both domestically and internationally. **CORETECH** will try to determine if change in intellectual property protection is needed and, if so, what form that change should take.